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A Job of Foundry Work.

At the Deering Reaper Works, in the Northwestern manufacturing district of Chicago, they finish a reaper every minute of the working day, in the various shop buildings located on the 52 acres of inclosed shop ground. These buildings include machine, foundry, and wood shops, assembling, storage and shipping buildings; a large twine factory where hundreds of girls spin the twine used to tie the bundles of grain turned off the Deering reapers when at work in the harvest field, and the large office buildings at the southeast corner of the works, shown in Fig. 1.

Fig. 1.

To describe these works in detail would not be possible just now for many reasons, and I choose, therefore, a foundry job that is, I think, specially interesting, though it may be worth while to glance down through one of the streets that pass through the works, as shown at Fig. 2.

All machines for farm use are exposed to the weather, and to dust; they must in all cases be sold at very low prices; they must also be extremely good; they must be very durable when their service is considered, and they must also, in the case of the self-binding reaping machine, perform with absolute certainty complicated operations on material very difficult to handle, and constantly varying in condition, quality and quantity. Thus the self-binding reaper must be able to go into any field of grain, tall or short, light or heavy, and convert the standing crop into tied bundles of uniform diameter, ready for the shock or stack. These are very hard conditions; the cost and the dust alike forbid close-fitting and delicate workmanship, in fact, machine work must be in every instance reduced to the lowest possible limit, and yet the parts must be thoroughly interchangeable, and must be capable of great endurance under very trying conditions. These exactions point at once to foundry work of the very highest class as the first requirement of the Deering establishment. The gray and malleable iron castings which go to make up a self-binding reaper must be uniformly true to pattern, and perfect in every particular; they must weigh the very least possible, hence they must be not only of the most suitable material, but of uniform excellence; since the best is only heavy and strong enough for its duties, anything less than the best would be worse than useless, as the margin of safety in all agricultural machines is reduced to its lowest economical point. Hence again, the skin of the castings must be cut as little as possible, no less for the sake of cheapness than for the preservation of strength, and the avoidance of rubbing surfaces to be lubricated with grit and oil in about equal proportions while at work in the dry and dusty harvest field. Thus it is clear the very best and cheapest foundry work which can possibly be made, must always be found in the large farm tool factories, of which the "Deering" is one of the largest in existence.

Fig. 2.

Fig. 3 shows a lot of "ground wheels," or "road wheels," or "bull wheels" for the Deering reaper. All of these names are in use in the shops, but as the wheel runs on the ground, "ground wheel" would seem to be a correctly descriptive name for the piece. These wheels weigh 180 pounds each, and are 33 inches outside diameter by 9¾ inches face. They are molded in the Deering Works for 16 cents apiece, and the price and the work done, and the elaborate and costly tools used in making this wheel so cheaply, form a very instructive example of the possibilities of the iron founder's art. They are made for a low piece price. They are very well made, each wheel being, within very small variation limits, an exact duplicate of every other, and the hands employed on these wheels make very good wages. A gang of six men, with a crane carrying on its jib an air hoist trolley, put up 160 molds

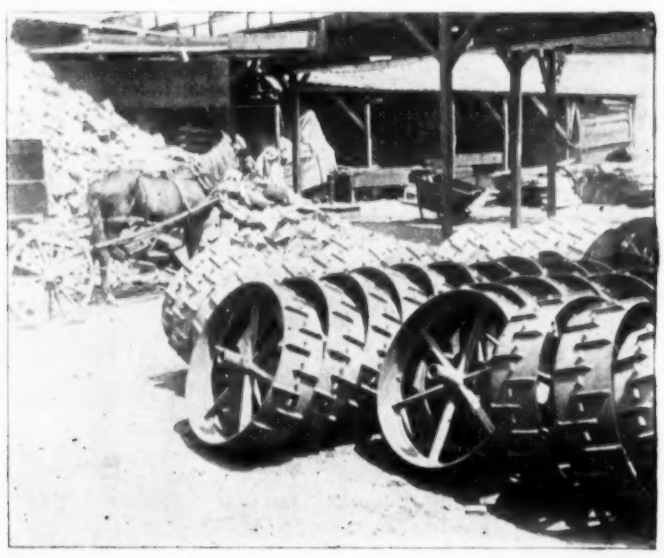


Fig. 3.

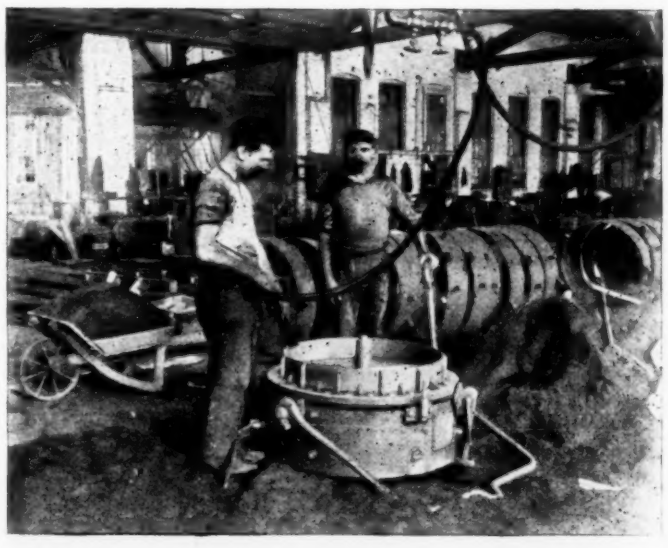


Fig. 5.

Fig. 6.

A JOB OF FOUNDRY WORK.

per day; at 16 cents per mold this makes the six hands earn $25.60 per day, which is $4.25 for each of the gang of six molders, share and share alike, as there is no foreman or leading hand, all ranking as equal. The average day's work is about eleven hours, however, so that these men make something less than 39 cents per hour. This is very much above common foundry wages, but it is quite common in factories demanding a very large output per square foot of shop floor to pay piece prices, which enable the rapid workman to earn good money by diligence.

The floor on which the Deering ground wheels are molded is wide enough to take a row of eight wheel flasks. The men who mold the wheels do not pour them; the pouring is done by pourers, who do nothing else but pour. The iron begins to come down about 9 o'clock, and pouring begins when

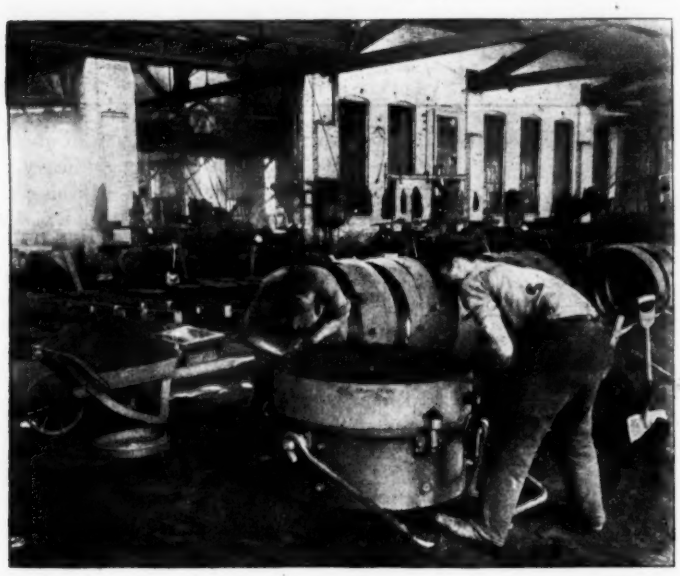


Fig. 7.

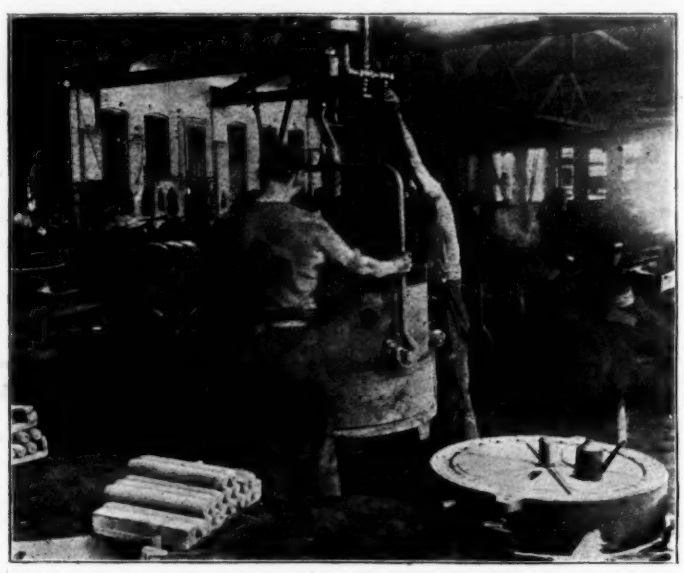


Fig. 8.

A Job of Foundry Work.

the molders have four rows of eight flasks each put up, and keeps about four rows behind the molders all day; the pourers pull the copes off the poured flasks at the proper time, and also shake out the work and pile up the flasks, so that the molders have nothing to do except to cut the sand over, and put up the molds. This ground wheel floor is covered by two light traveling cranes, one for the pourers, which only carries a trolley with a chain and bail for the ladle holding about 1,500 pounds of iron, and pouring eight wheels at one filling. The molder's crane trolley carries an air hoist, and the air is also cocked to a blowing hose to give a hand blast for blowing the pattern clean, as shown in Fig. 5, instead of brushing it clean, the air blast being much better and quicker than brushing.

These ground wheels are spoken of as "machine molded," but "machine molded" is a very elastic term, and may mean either the use of an elaborate machine which rams the mold or presses the sand around the pattern in the flask, and also withdraws the pattern from the sand, or it may mean merely that the follow board is provided with means for mechanically drawing the pattern into the depth of the follow board, so that the pattern is machine drawn, while the filling and ramming of the flask is done altogether by hand. This last is the case in this ground wheel job. The "follow board," as very clearly shown in Fig. 5, takes the form of a hollow-flanged cast-iron cylinder having an inside diameter greater than the outside diameter of the wheel pattern, so that the pattern can be drawn down into the follow board, which is about twice the depth of the pattern width. The top of this round follow board is finished flat, and is also cut to the exact shape of the wheel rim, arms, and hub where the two halves of the pattern join, and this follow board is further provided with internal mechanism, connected with a shaft journaled in the cylindrical walls of the follow board, and having a projecting squared end to take a wrench, by which the shaft may be partly turned when it is desired to pull the pattern down through the top of the follow board, or to push the pattern up through the follow board so that it will stand as in Fig. 5, wholly above the flat follow board top. Means are provided for guiding the pattern as it travels up and down in this hollow cylindrical follow board, which is not called a follow board at all, but is spoken of as a "molding machine." There are two of these molding machines, each carrying one-half the wheel pattern; one machine makes the nowel, and the other the cope of the wheel mold. The one shown in these figures makes the nowel. The molding machine is hung on trunnions in a high bail, as also clearly shown, lying down, in Fig. 5, by which bail the machine and half mold which it carries may be readily hooked to the air hoist piston rod, and lifted and turned over as occasion requires.

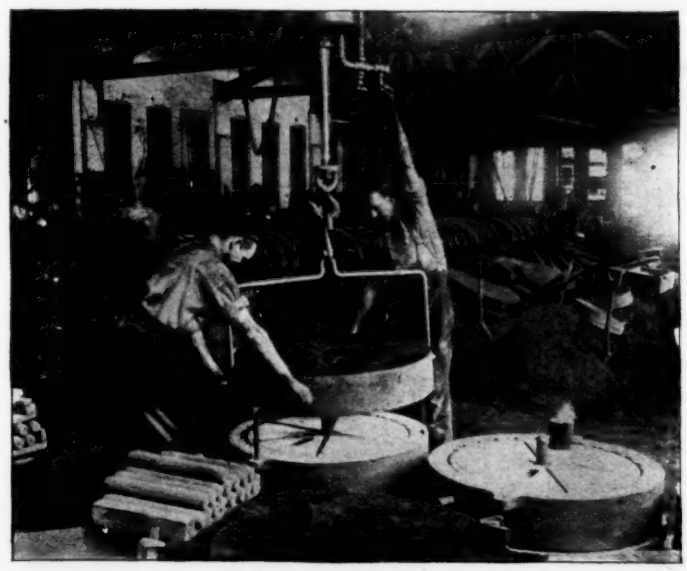
In Fig. 5 the machine has been set down on the floor near the sand heap, and by turning the shaft mentioned the pattern has been pushed up through the top of the follow board, which it exactly fits, and the molder is blowing the pattern clean with an air blast at 80 pounds pressure, which is very noisy as well as very effective. All that follows, except Fig. 9 refers to the nowel only, the cope shown in Fig. 9 as being closed on the nowel, being made on another similar molding machine by others of the gang of six hands on the job. These pictures were made in the noon hour, two of the men putting up the nowel for the convenience of the photographer who found it quite impossible to get pictures in the regular course of the work. The Deering foundry floors are far too wide to be very well lighted from the sides, and as there was only 30 minutes' time for all of the pictures, and the artist had a 1,500-pound ladle of melted iron in *very* sensibly close rear proximity while his head was under the focusing cloth, these pictures recall vivid personal memories. That such pictures could be taken at all under the circumstances speaks volumes for the modern development of photographic apparatus adapted to use by those who are not professional photographers. There was a combination of darkness, flying sand, and melted iron, with hungry workmen to pose, and a foundry boss who, while anxious to oblige, was perfectly aware that he must have a full day's work off that particular floor.

Thanks are herewith tendered to all, to the head foundryman and to the molders, drawing the line, however, at the pourers with their 1,500-pound ladle of melted iron in the close rear of the artist, as before mentioned and very warmly remembered.

Fig. 6 shows the circular nowel, half of the flask in place and the men in the act of ramming it up. The flying minutes forbade more than two trials for a picture of the spirited action shown by one of the molders in "tramping off" this flask, and both proved, unfortunately, failures.

Fig. 7, both the men striking off the bottom of the nowel with an iron strike, was clearly a success, however, as the engraving shows.

In Fig. 8, the whole job is swung by the bail in the crane; a wooden follow board has been clamped to the bottom of the nowel, and the machine and the nowel turned on the machine trunnions in the bail, so that the machine is now on top, above the nowel with the follow board or bottom board, rather, clamped to its under side; and one workman steadies the mold and guides it into its place in the row, next the last one made, which is shown at the right, its top surface dusted with flour, the hub core set, and a blazing oil lamp sitting on the top of it. To the left of the middle front is shown a pile of hub cores, beautiful specimens, as perfect as if turned.



A Job of Foundry Work.—Fig. 9.

The core making at Deering's seems wonderfully good all through; the core boxes, many of them quite intricate, are fine examples of design and construction, and the vast number of cores required gives the core makers a marvelous expertness. Indeed, every detail of the foundry work at the Deering shops was carried out to an admirable degree of perfection.

Fig. 9, "closing up," shows a cope made by the other men of the gang on the other molding machine, swung by its bail in the air hoist hook and being guided on to the flask pins as the man with his hand on the air valve wheel lets the cope down to place on the nowel, which has been duly floured on top, and had the hub core set in the middle.

These wheel patterns are, of course, finished all over to absolute perfection, so that they draw through the metal follow board, or draw plate, with such certainty of not disturbing the sand that the molders did not even look at the mold after drawing the pattern. They simply put the wrench on the squared end of the machine shaft as soon as the lowering of the nowel, shown in Fig. 8, was completed, gave the shaft a half turn, and snatched the machine up with the air hoist and raced it back to the sand heap, turning it over as they went, and in an instant it was down on the floor; the shaft had another half turn bringing the pattern up on top as in Fig. 5, and the horrible hiss of the air hose blowing the pattern clean was heard again.

One hundred and sixty flasks put up in 660 minutes of working time is one flask for every 4⅛ minutes; that is to say, every 4⅛ minutes for 11 hours this gang of six men makes the cope and the nowel, flours the molds, sets the core, and closes the flask and is back at the sand heap ready to begin another. Compare this with the procedure of molding such a wheel in a jobbing foundry where it would take half an hour to hunt up a flask and get it on the floor and clay washed ready to begin work. The cost of the Deering patterns or "machines" for molding this ground wheel cannot be given; it may have been as much as $400, perhaps not half that; tool making and pattern making cost various prices; a trip through the West will convince any man of that fact. But suppose the patterns cost a dollar a day, and the iron in the ladle cost 6½ mills per pound, which is not far out for a guess, and the pourers cost $5 a day for the two of them, this gives only $29.10 for labor and wear and tear of tools per day, and makes these big 180-pound wheels cost only $1.36 each, short cost, to the Deering Company; and it would be difficult to find items to bring the long cost or "all in" shop cost to more than $1.50 each, or a good deal less than one cent a pound for this elegant job of founding.

This is not nearly so cheap as some work noticed and noted, but it is cheap enough, probably, to make some manufacturers think twice before they put the matter out of mind altogether.

Easy Way.

Compounding—Its Thermal and Mechanical Advantages Under Proper Conditions.

By W. H. Booth.

The compound working of the steam engine is merely one of the means employed to reduce the thermal losses which result from the varying temperatures of the metal of the cylinder to which the steam is exposed. But compounding has another and quite independent result. It causes not only a reduction in the range of temperature in each cylinder, and so correspondingly diminishes the condensation therein of the entering steam, but it also reduces the pressure on any one piston, or rather it reduces the difference of pressure upon opposite sides of the same piston.

In a single-cylinder engine with steam at, say, 100 pounds pressure there is a difference of pressure of 100 pounds between the two

sides of the piston, and this pressure is trying to leak past the piston all round its circumference. But if we first admit steam to a cylinder of one-third the capacity and expand down to 40 pounds pressure in the first cylinder, and complete the expansion in the second cylinder, which will be as large as the cylinder of a single-cylinder engine, it is obvious that there is now only 60 pounds of leakage pressure in the first cylinder, and that there is a much less periphery of piston and valve at which even this reduced pressure can act.

By compounding we have therefore reduced the acting leakage pressure and the leakage area, we have reduced the range of temperature of the metal of the cylinder, and also the area of the metal exposed to the hot steam, and we have reduced the size of the hottest cylinder and so diminished the radiation from the hottest metal. All these are obvious facts sufficient to account for the economy of compounding, but at the same

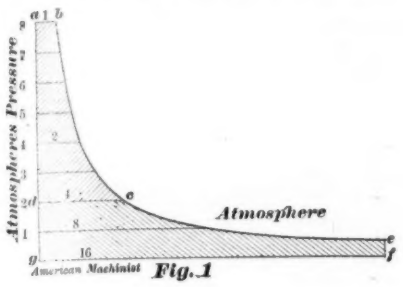


Fig. 1

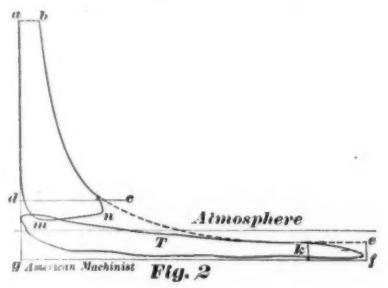


Fig. 2

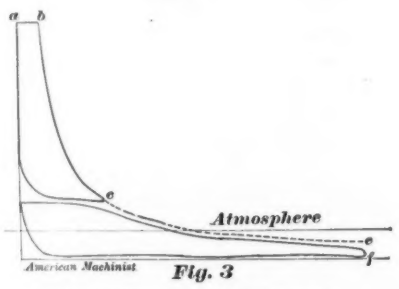


Fig. 3

COMPOUND STEAM ENGINES.

time we have introduced friction and complication which go so far to neutralize the above benefits that it only pays to compound when the boiler pressure gets to be 80 to 100 pounds, and there are evidences that the compound engine could be economically employed in place of the triple-expansion engine for pressures to which the latter engine is considered necessary. Economy arises then from compounding both from thermal causes and mechanical causes, and the latter causes will be of less moment as the quality of workmanship improves. But compounding enables us to extend the pressure on the moving parts of an engine throughout a greater part of the stroke and of more equable intensity, thereby reducing stresses and friction and conducing to more even turning moment.

Where a simple engine is compounded by the addition of a cylinder it will occur that there is a considerable drop in pressure between the two cylinders, and though this is bad in principle it cannot always be completely avoided with convenience because it may be due to want of capacity of the low-pressure steam ports and passages, which, sufficient for a simple engine and boiler pressure steam, are insufficient to carry the almost equal weight of low-pressure steam of larger volume.

It is thus necessary that the steam ports of the last cylinder of a compound engine be larger than they would be for a cylinder of equal size taking steam direct from the boiler. But granting suitable ports and passages, how should a compound engine be worked? It should be arranged to expand its steam to about 7 to 10 pounds final pressure, and to have about equal expansion in each cylinder.

Thus for an expansion of 16 times the first cylinder needs to be about one-fourth the capacity of the second, for $\sqrt{16} = 4$. Steam would be cut off at about one-fourth the stroke in the first cylinder and expanded four times, and then exhausted to the second cylinder. Thus in Fig. 1 we have a theoretical diagram of a perfect gas expanding from eight atmospheres pressure to half an atmosphere, doubling its volume as it halves its pressure, which is sufficient for illustration, though not exactly the case with steam.

If this ideal engine were compounded we should get as the high-pressure diagram the figure *a*, *b*, *c*, *d*, while *d*, *c*, *e*, *f*, *g* would be the low-pressure figure. But quite commonly in place of diagrams even approaching this theoretical form we find they are

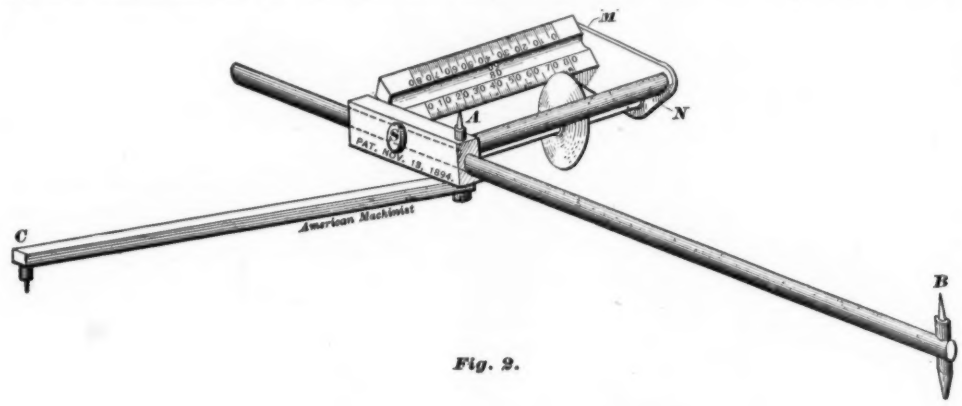


Fig. 2.

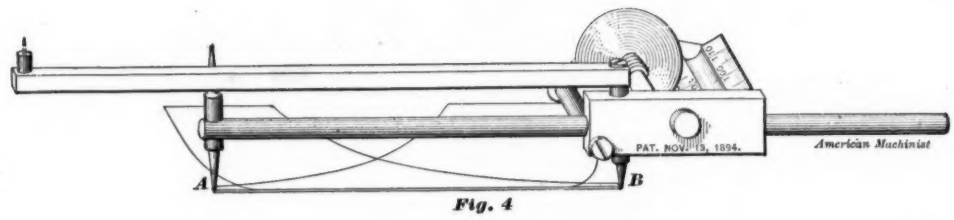


Fig. 4

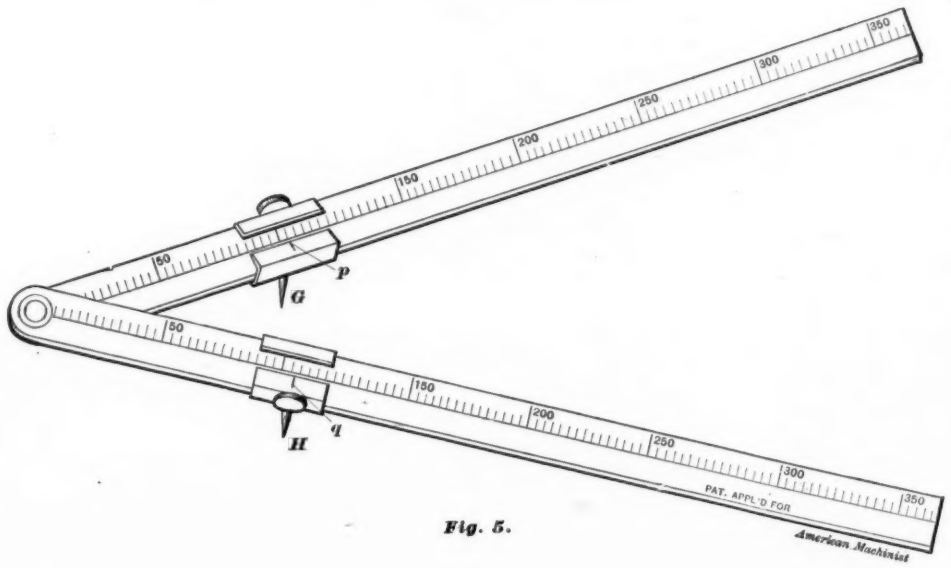


Fig. 5.

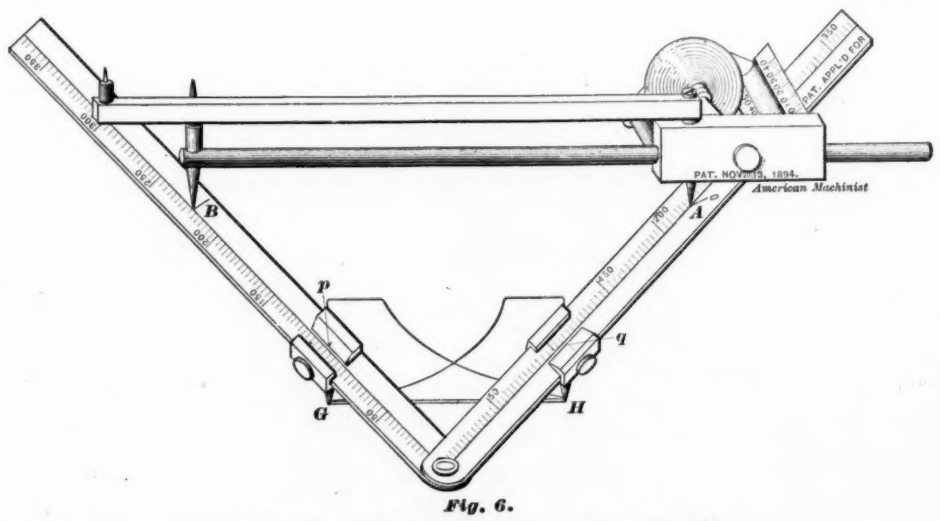


Fig. 6.

A HORSE-POWER PLANIMETER.—SEE PAGE 544.

more like Fig. 2. The valve of the low-pressure cylinder is kept open too long, and thoroughly empties the pipes or the receiver between the two cylinders until the pressure in them is reduced to that at the point *k*, Fig. 2, where the admission may perhaps extend. Thus when next the high-pressure cylinder discharges, it finds a large, empty space which must be filled, and this it is that causes that great drop from *c* to *n* in the high-pressure exhaust, and the backward downward slant of the exhaust line to *m*. Such engines are frequently found where the first cylinder is doing by far the greater share of the duty, and much of the effect of compounding is lost, for there is not that reduction of the range of temperature in one cylinder nor the reduction of the difference of pressure between the two sides of the piston that we have a right to expect, while the pressure upon the large cylinder is barely enough to start it from rest. This is very much the sort of thing that obtained in the Woolf engine. A very small first cylinder served merely as a measuring pot to deliver cylinders of steam to the main cylinder, and as both cylinders carried steam full stroke or nearly so, the full range of pressure as far as the point *k* was felt in the first cylinder. If called in to an engine giving diagrams as in Fig. 2, the thing to be done is very simple. It consists in arranging an earlier cut-off in the large cylinder. If this be done this cylinder can only take steam as far as, we will say, *T*, and when the next exhaust comes from the first cylinder it finds more steam in the pipes, and we can go on doing this until finally we get diagrams like Fig. 3. Here we have repressed the escape to the low-pressure cylinder until when the high-pressure exhaust opens the exhaust line starts away directly from the

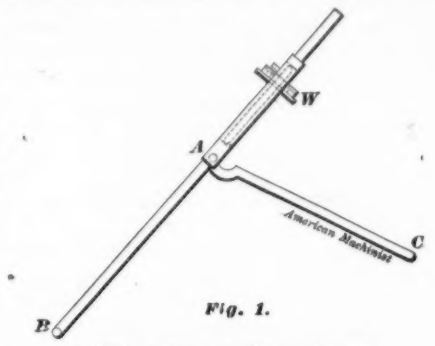


Fig. 1.

A HORSE-POWER PLANIMETER.

point *c*, and never gets any lower. Rather it slopes upwards, and there is so much steam in the pipes that a well-formed cut-off diagram is gotten from the second cylinder which is now doing a much greater share of the work, and there is a better temperature distribution combined with less leakage pressure on the first piston and valves. These diagrams are not actual diagrams, but if actual diagrams be taken, the great gap seen in Fig. 2 between the diagrams and the dotted hyperbolic curve will be noticed to be very much less when the valves are arranged as in Fig. 3. It is frequently the case that where worked as in Fig. 2 the steam ports of the large cylinder are insufficient to admit steam properly, and the result is too great a pressure difference between the two cylinders without any counteracting advantage. In good practice the initial pressure in the second cylinder should be the terminal pressure in the first cylinder, or nearly so, as shown in Fig. 3, whereas in Fig. 2 the low-pressure initial is that of the point *n* after the drop *c n*, instead of being the pressure of the point *c*. All compound engines possess some receiver volume in the shape of the junction pipes from cylinder to cylinder, but there should be a reasonably big receiver capacity —so big that the valve of the large cylinder may be set almost on the supposition that the cylinder was an independent cylinder drawing steam from a boiler. Remember, it is quite as important to work the cylinders properly in a compound engine as in a simple engine. Indeed it is almost more so, for unless we are to take full advantage of the good points of a compound engine, we shall find ourselves overloaded by its faults, one of which obviously is greater friction and more working parts. To thoroughly comprehend the thermal actions in the compound engine in respect of temperature ranges one need only sit down with a copy of Pray's tables and suitable scales, and the diagrams, and find the temperatures corresponding to the highest and lowest points in the diagrams. The relative powers developed in the two cylinders may be worked out at the same time. With an unlimited supply of steam the later the cut-off the greater will be the power developed, but where merely so much steam is given to be used, as in the compound engine, then the greatest power is obtained by early cut-off. It is easy to see this must be so. The first cylinder is really acting as a pump and pushing forward a fixed volume of steam per stroke, and the only way of escape is through the low-pressure cylinder. This must necessarily use all the steam and obviously what it does not use one stroke must be used and at a higher pressure on the next stroke. Indeed, by cutting off early enough, we could bring boiler pressure upon the low-pressure piston, the high-pressure diagram becoming a horizontal line *a b*, and the low-pressure diagram becoming as Fig. 1. Almost invariably my

own experience of engines has led me to consider that the chief fault of compound practice is that the low-pressure cylinder is not charged with its fair share of the load, whereas it really ought to have the most. Too often the low-pressure piston gets too little steam to move it the first bit of its stroke. Yet it is an easy matter to change Fig. 2 to Fig. 3.

A Horse-Power Planimeter.

We present on the preceding page engravings of a planimeter which reads horse-power direct from the indicator card. The method by which this is accomplished is best shown by comparison with the usual instrument.

The usual polar planimeter, Fig. 1, has a recording wheel W whose axis is parallel to the tracer bar $A\ B$. This wheel scrapes along the paper for all movements parallel to the tracer bar, but rolls for all movements perpendicular to it. After tracing a figure the result of such perpendicular movement is read from the graduated circumference of the wheel W. The instrument to which we call attention acts on an entirely different principle. Its wheel W (Fig. 2) both rolls and slides on its axis which is perpendicular to the tracer bar $A\ B$. It rolls for all movements parallel to the tracer bar and slides on its axis for all movements perpendicular to it. After tracing a figure the result of such perpendicular movement is read from the scale next the wheel (Fig. 2). This scale is triangular, and any one of its six graduated edges can be brought next the wheel. Thus the wheel movement can be read in the unit best suited to the work, and all factors or corrections are avoided.

The general equation of the polar planimeter has been frequently established. Probably the most elegant proof covering both constructions is that presented by Prof. Wm. H. Echols in the "Annals of Mathematics," Vol. V., p. 11, August, 1889. This general equation asserts that with any polar planimeter, after tracing a figure, the wheel movement equals the area of the figure divided by the length of the tracer bar. This equation is independent of the position of the wheel W or the length of the radius bar $A\ C$, and its only condition is that the recorded movement shall be perpendicular to the tracer bar.

The reading of the instrument equals scale multiplied by wheel movement, and since

$$\text{wheel movement} = \frac{\text{area}}{A\ B}$$

we note that

$$\text{reading} = \text{scale} \times \frac{\text{area}}{A\ B}$$

which is the fundamental equation of the instrument upon which all its operations are based.

To read square inches we set the points A and B to the distance apart corresponding to the scale which is next the wheel. Thus, if the 40 scale were next the wheel, we would set A and B 4 inches apart. The instrument would then read square inches and tenths of a square inch, for the reading, on going over one square inch $= 40 \times \frac{1}{4} = 10$. If the figure were large and we desired the convenience of a longer tracer arm, we would turn next the wheel the 100 scale, and set A and B 10 inches apart, and still read to same unit. By proper selection of scale and arm length the instrument will read to any unit, such as square feet or yards on the different scale drawings. Thus to read square feet on a drawing $\frac{1}{2}$ inch to the foot, we use 30 scale, and A and B $7\frac{1}{2}$ inches apart, or for square yards on a drawing $\frac{3}{8}$ inch to the foot, the 60 scale, and A and B $7\frac{6}{10}$ inches apart as given in the table accompanying the instrument.

To read the mean effective pressure of an indicator card, we turn next the wheel the scale which corresponds to the spring with which the card is taken, and set points A and B to card length (Fig. 4). On tracing card

$$\text{the reading} = \frac{\text{area}}{A\ B} \times \text{scale} = \frac{\text{card area}}{\text{card length}} \times \text{spring} = \text{M. E. P.}$$

The horse-power attachment (Fig. 5) is a double-hinged scale with a sliding pointer on each arm. Supplied with the instrument is a book of tables which give the value of $\frac{33{,}000}{\text{piston area} \times \text{stroke}}$ for engines from 8″x8″ to 110″x72″. As these tables run by half-inch differences in diameters, and inch differences in strokes, they may be said to give this value for any engine. To read horse-power, the lines p and q (Fig. 5) are set to the division corresponding to the revolutions per minute of the engine, and the points G and H are set to card length (Fig. 6). The scale which corresponds to the spring with which the card is taken is turned next the wheel, and points A and B are set to the division corresponding to the value $\frac{33{,}000}{\text{piston area} \times \text{stroke}}$ as given by the tables. The attachment is removed, and the card traced. The reading will be horse-power. For by similar triangles (Fig. 6)

$$A\ B : \frac{33{,}000}{\text{piston area} \times \text{stroke}} :: \text{card length} : \text{revolutions per minute, or}$$

$$A\ B = \frac{33{,}000 \times \text{card length}}{\text{piston area} \times \text{stroke} \times \text{rev. per min.}}$$

The reading $=$

$$\text{scale} \times \frac{\text{area}}{A\ B} = \text{spring} \times \frac{\text{card area}}{A\ B}$$

and substituting $A\ B$,

$$\text{reading} = \frac{\text{spring} \times \text{card area} \times \text{piston area} \times \text{stroke} \times \text{rev. per minute}}{33{,}000 \times \text{card length}} =$$

$$\frac{\text{card area} \times \text{spring}}{\text{card length}} \times \frac{\text{piston area} \times \text{stroke} \times \text{rev. per min.}}{33{,}000} = \text{M. E. P.} \times \text{constant of engine} = \text{horse-power.}$$

If both cards are, as usual, on the same paper we start the tracer point at the intersection of the two expansion curves, and tracing first one and then the other we read the total horse-power direct from the scale. Thus the instrument performs automatically all the operations called for by the usual formula for horse-power, and does it without sacrificing accuracy, simplicity or portability.

One of the instruments which we have submitted to some very severe tests proves itself very accurate, and it is evident from its construction that wear which can affect its accuracy will take place very slowly, if at all. The wheel is mounted upon a glass rod, and needs no lubrication. The scale is of box wood, finely graduated, and the rest of the instrument is of brass (nickel plated) and steel. It is supplied by its inventor, E. J. Willis, M. E., 211 East Franklin street, Richmond, Va.

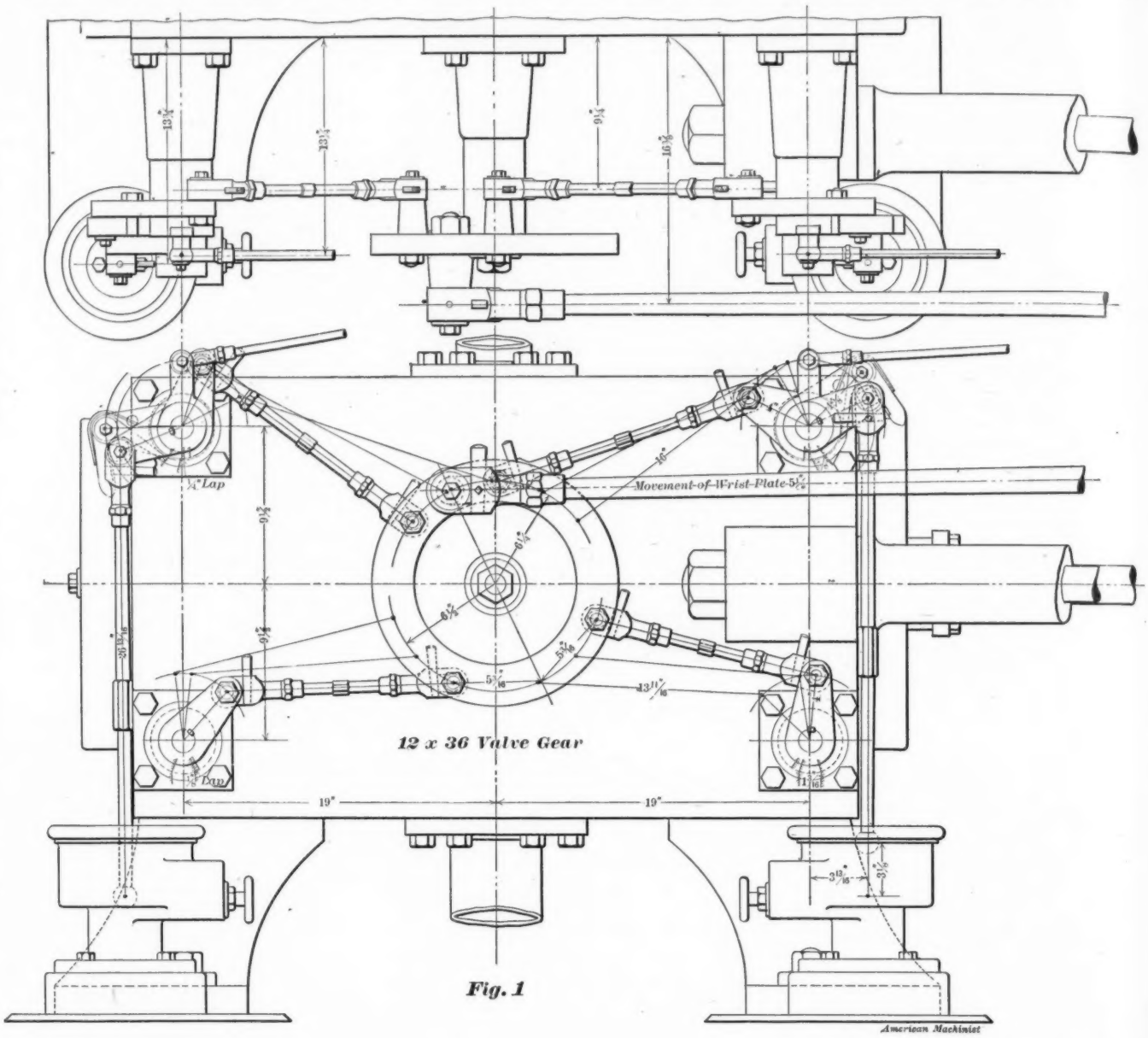
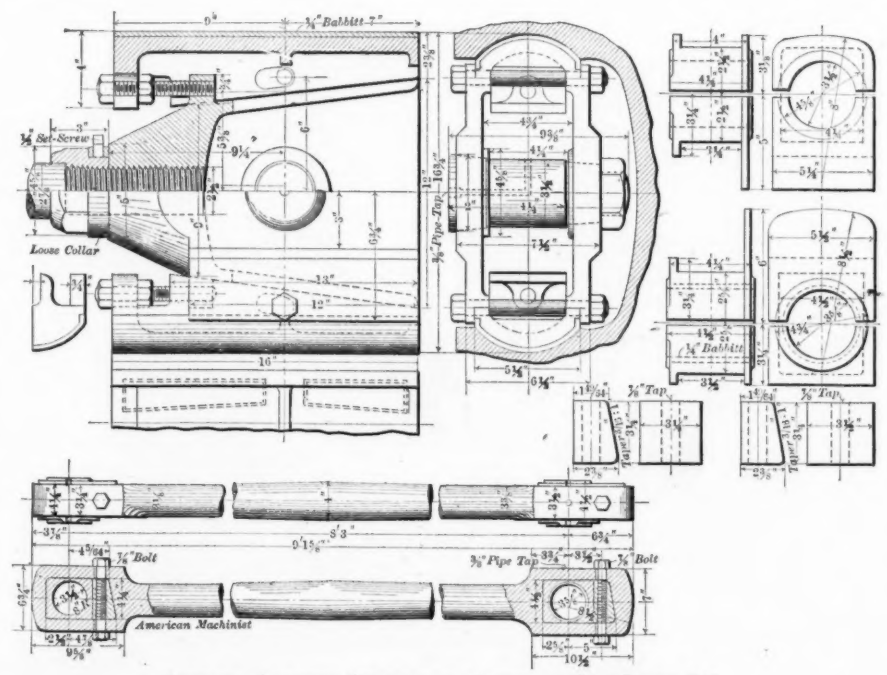


Fig. 1



CORLISS TANDEM COMPOUND ENGINE.—SEE PAGE 545.

Differences in Copper.

J. T. Milton, in *The Practical Engineer*, London, calls attention to the above subject. To the average mechanic copper is copper, just as steel used to be steel; but there is copper and copper. The metal is practically never pure. No metal in common use probably contains such an amount of different impurities, and these naturally have their effect upon the reliability of the metal. While copper is to-day chemically purer than that produced years ago, it is believed by many to be inferior in lasting qualities, both as to resisting corrosion and in withstanding repeated strains without cracking. For some purposes what might be called impurities are added to the copper in its manufacture, with the result of improving it in some of its properties. Arsenic up to ½ per cent. probably improves both the tensile strength and the ductility of copper. Bismuth, on the contrary, often occurring in copper, is always objectionable, even one-tenth of 1 per cent. making it absolutely unreliable when heated above 212 degrees. Lead in small quantities has little bad effect, while nickel and silver seem to be beneficial in any proportion of mixture. In copper made by smelting, oxygen seems to be always required to give it ductility, the amount required seeming to vary with the proportions of the other impurities present. Coppersmiths need to know that copper may

be made to give up its oxygen if heated in a "reducing flame," or a flame not fully charged with oxygen, while oxygen from an oxidizing flame will not penetrate or change the copper, but will only form a scale upon the surface. The tensile strength and ductility of copper vary widely according to the mechanical treatment that it undergoes. If properly annealed its tensile strength is low and its ductility is high. A copper tube was lately drawn in one operation from No. 8 wire gage to No. 11, an excessive draw, more than doubling its length. Its tensile strength when drawn was 24.38 tons per square inch, but its elongation was only 3.1 per cent. in 4 inches. After annealing or possibly only partial annealing, its tensile strength was 16.66 tons per square inch, and its elongation was 44 per cent. in 4 inches. In tube works the tubes are annealed after every draw. They are raised to a temperature of 1,500 degrees to 1,650 degrees, and kept at that temperature for some time, and then quenched in water. The tubes are uniformly heated over their whole length in a clear flame with an excess of oxygen. In the coppersmith's shop sheets and pipes are heated over open coke fires, the flame may possibly be "reducing," or deficient in oxygen, if the fire is thick. The sheet or pipe is moved about over the fire and heated in successive spots to a dull red, and is then either quenched or allowed to cool, and is considered annealed. So it depends upon the workman's care and judgment to ensure that every part is sufficiently heated, and some may escape. The heating cannot be uniform, and no part is heated as hot as in the tube works.

[We once had to do with the manufacture, in considerable quantities, of cylindrical copper baskets for centrifugal machines used in laundries, woolen mills, and various other places for drying textile or fibrous materials. The baskets were made of various sizes, a common size being 36 inches diameter by 20 inches deep. The copper sheet forming the periphery of the basket $\frac{1}{10}$ inch thick, was received already sheared to the proper width, and long enough to form the complete circle with enough to make the joint. The entire sheet, or several of them together, were drilled with holes, say, $\frac{5}{16}$ inch diameter, and about 2 inches apart in all directions. The sheet was then rolled up, and the ends brazed together to form the cylinder of the required diameter, and holes were drilled in the brazed portion similar to those in the rest of the sheet. After the brazing and the drilling the entire shell was tinned upon the inside. The heat required for the tinning did not seem to affect the tensile strength of the sheet, while the heat of brazing very evidently did. After the shell was riveted to the bottom of the basket, and the top was riveted in, it was then complete. When the baskets went out into service they almost invariably began to bulge out at the brazed joint, in some cases the bulge becoming very large. When the bulge was discovered the basket was taken out, and another one substituted. In this case the great elongation accompanying the low tensile strength was an element of safety, as it allowed quite a large bulging of the sheet before it gave away, and there was always a sufficient notice of impending disaster. The bulging of the baskets became so common that the brazing of the joints was abandoned, and the ends of the sheet were butted and united by an outside strap with three rows of rivets in each end of the sheet, and a strip was also riveted upon the opposite side of the basket to balance it. The joint thus made did not weaken the sheet as the rivet holes did not cut away any more of its section than was already cut away by the water holes. The baskets made in this way were probably double as strong as the brazed baskets, but they did not give the same timely notice before bursting.

A growing distrust of copper for steam pipes, with the increasing pressures and accompanying temperatures employed, has led to the use of pipes made of comparatively thin copper closely wound with steel wire, the combination forming the lightest pipe for the strength required ever produced, and we may expect to see them widely used.—ED.]

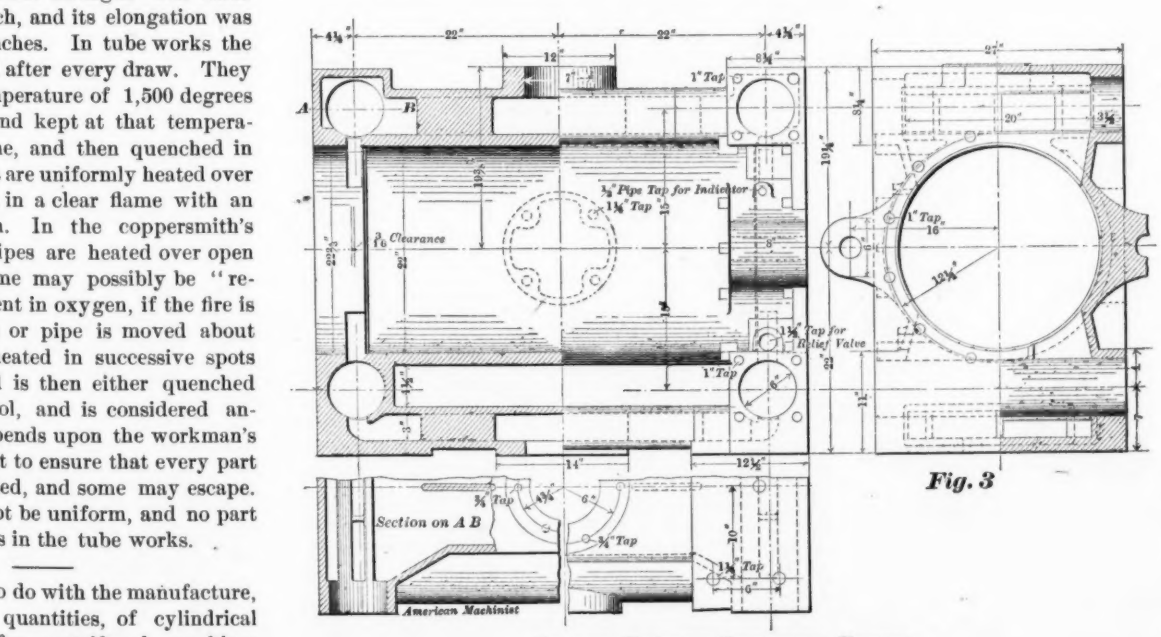


Fig. 2

CORLISS TANDEM COMPOUND ENGINE.

Fig. 3

CORLISS TANDEM COMPOUND ENGINE.

Corliss Tandem Compound Engine.

The accompanying illustrations are reproductions on a small scale of working drawings for a Corliss tandem compound engine designed by C. M. Giddings, Rockford, Ill., who has had considerable experience in designing this and other lines of machinery while connected with well-known manufacturing concerns. The high-pressure cylinder of this engine is 12 inches diameter; low-pressure cylinder, 22 inches diameter; stroke 36 inches. Figs. 1 and 2 show the valve gear for the high and low-pressure cylinders, respectively; Fig. 3 the low-pressure cylinder; and Fig. 4 the cross-head, connecting rod and details.

These drawings are self-explanatory, and need no further remarks from us. They are not presented so much as illustrations of engines, as to show the line of business entered into by Mr. Giddings, which we believe to be a new one, and will enable a machine builder to buy his designs ready-made, so to speak.

How to Hire Hands—Delicate Correspondence.

I had been shown a great number of extremely interesting operations, and case after case filled with the finest jigs and special tools; I had passed through department after department full of busy workers, many of them women of evidently unusual intelligence and skill; I had asked some questions and had received a vast amount of most interesting information. The vice-president wound an almost invisible filament of metal on a folded paper—it was like a golden hair of inconceivable fineness—a sample of wire one thousandth of an inch in diameter drawn from an alloy of his own discovery, and gave it to me, remarking that it was a great achievement to draw wire of that fineness of that alloy, even though the draw plates were fine white diamonds pierced with the needful almost undiscoverable holes, and the wire drawer was his most experienced girl. This gave me my opportunity. The work I had seen was of the most exact description, in many instances gaging closer than good

watch work, and the location of the factory was not in a town noted for the extreme skill of its work people. "Where do you get your help?" I asked. "Do you make it yourself?"

"Almost all of it," replied the vice-president, "all of it, I might say. All of our girls are of our own training exclusively, and our skilled workmen have been trained and specialized here so that they are not at all what they were when they came to us."

"They never leave you?"

"We had one strike, due entirely to want of tact on the part of a superintendent; that cost us some men we did not wish to lose. We do not think it good policy to take a man back who once leaves us; we prefer to take new hands, and form them under the influence of our system. Our work is, as you have seen, minutely subdivided; we keep careful histories of all operations, elaborate drawings of all tools, with records of performance, and so are able to illuminate the projected doings of the future with the light of experience. We find that extremely skillful men from other establishments are slower to fall into our routine than younger and less experienced hands. To tell you the whole truth, and to touch a very annoying subject, our establishment seems to be regarded as a kind of nursery or training school for fine workers by other concerns in the same line, who seem to have no scruple against sending their agents here to take our help away—yes, always by the offer of more pay. As you see, our hands are well treated, and increased pay is the only possible inducement they can have to leave us and take service elsewhere. It is often, always, I may say, extremely annoying to have men we want to use taken away from us; sometimes it is extremely costly to us as well as annoying; and we have not even the small consolation of knowing that men we liked have bettered themselves by a change, for they seldom stay long in their new places. It is our aim here to make the system govern everything; hence our best hands are those who most readily fall under control of our special methods. In a new shop, these valued workers of ours find either a new system or no system at all, and they are in the position of trained soldiers called upon to do independent scouting duty. They do not produce the results expected in their new places, and the effect of the change is seldom satisfactory on either side. But the other houses continue the practice of hiring my men away. Only yesterday I lost two men whom I cannot replace immediately, and whom I need very much. No, I have never said anything about it, until this last case of the men who went yesterday. I wrote a letter which I think will reach the management of the establishment which hired those two men away. Yes, you can have it for publication with my name if you wish, but I do not think it would be best to give the name of the company hiring my men away from me, though it would be no more than simple justice to give the letter in full as I will give it to you. The subject is certainly of importance, and is one of deep interest to every manufacturer who endeavors to reach a high standard of excellence in his output. I shall be glad to have the Machinist print what I have just said to you, and what I said in my letter to my rival. This practice of enticing men away by offer of more pay is not a good one for either of the three principal parties; it is bad for me to lose men I need, and the men do not gain by it for reasons I have stated, and the new employer does not find the man who fits my system perfectly filling a similar position in his factory; so no one is benefited in the long run. I think a full consideration of all sides of the transaction will lead to its discontinuance. I have had no reply to my letter to the X. Company. I shall be glad to let you have it when it comes."

This is the letter the vice-president wrote to the X. Company:

[Copy.]

April 10, 1895.

J. F. K., Esq.,
Care X. Elec. & Mfg. Co.

My Dear K.:—I am constrained to write to you about a matter with which I am quite sure you have nothing to do, but in which I think you can be of some service to both the X. Company and myself.

For several years persons in the employ of the X. Company have been in the habit of, from time to time, recruiting the force of mechanics employed by that company from the ranks of men employed in my factory, and doing so by offering inducements in the way of larger salary than is paid in this locality. In one sense I presume I ought to take it as a compliment, and in another sense I suppose I ought to take it as an insult. As a compliment, because it is evident that unless the mechanical work of the company I am identified with was of a high order, its mechanics would not be sought for. As an insult, because the action might be construed to assume that the good work turned out of this factory is due to the mechanics employed rather than to the system of planning and doing the work.

During the past week there has been another employe of the X. Company in Y. for the purpose of enticing away from the service of this company several of the employes, and he has secured two of my men at an advanced rate.

Honorable manufacturing concerns engaged in the manufacture of machinery are particularly cautious to avoid doing anything having the appearance of enticing men away from their competitors, and moreover, most concerns of long experience in manufacturing know that nothing is gained, in the end, by such practice. They recognize the fact that there are plenty of sufficiently skilled mechanics in this country to enable them to properly conduct their business, and that they are easily obtainable by the simple means of making their wants known through the technical press.

Of course, the practice of enticing away employes must sometimes cause temporary inconvenience, and frequently some loss to the party or parties who are its victims; and there can be no doubt about it being not only reprehensible, but also a thoroughly dishonorable and utterly foolish practice. I know, however, that it has been very commonly practiced by electrical corporations, who, indeed, have never hesitated to violate any law of business morality, even when the inevitable results to themselves were sure to be most disastrous. In my opinion, those corporations guilty of it have never gained any advantage by the practice, but have invariably lost, and I believe there is a good reason for it.

Long experience in manufacturing enterprises has convinced me that good work is more the result of *personal effort* and *knowledge* on the part of the *managing head* of a concern than the result of the skill of the help employed. If the man at the head of a concern does not know what constitutes good work, and the methods essential for its economical production, mechanical skill, no matter how great, will not lead to success. Indeed, I have long been convinced that it is an absolute truth that the most skilled mechanics are generally the least able to produce or devise methods of producing good work *commercially*.

Unless the X. Company is particularly desirous of inflicting injury upon me, putting me to inconvenience and antagonizing me, it would be just as easy, less expensive and more honorable to secure the help it needs in other ways than by permitting its employes to act as recruiting agents in my factory.

I ask you, therefore, to do me the favor of bringing the matter to the attention of the proper authorities of the X. Company, so that they may be made fully acquainted with the actions of their employes in this matter.

Yours very truly,
Z., Vice-President.

We have received from C. E. Laetzer, Williamsport, Pa., a neat and handy "U. S. Standard Thread Reference Gage." It is of sheet steel, with all the dimensions of standard threads from ¼ inch to 6 inches upon one side, and rules for its use and also for computing change gears upon the other.

LETTERS FROM PRACTICAL MEN.

Weight—Force—Mass.

Editor American Machinist:

The following article is an answer to some of the questions asked by "Bell Crank" and "Anti-Know-All," in the issue of the American Machinist for March 28th.

When a person tries to lift a free body he encounters a resistance, and this resistance is due to the attraction of the earth. According as the resistance is great or slight, he calls the body heavy or light. If two homogeneous bodies, A and B, are of the same size (equal volumes), and A offers a greater resistance to being lifted than B, A is said to be heavier than B. The only reason that A offers greater resistance than B is because A contains more *matter* than B. Were the volume of B to be increased until it contained the same amount of matter as A, it would then offer the same amount of resistance to being lifted that A offered. This resistance which all bodies offer to being lifted is called *weight*.

In order to compare the weights of different bodies it is necessary to have a standard. The standard weight used in English-speaking countries is a bar of platinum owned by the British Government, which has been officially declared to weigh one pound, or 7,000 grains.

Force may be defined as that which produces or tends to produce or destroy motion. In order to lift a body it is necessary to apply a force, and this force varies with the weight of the body. Ordinarily, force is regarded as a pressure or a pull. In other words, a force of 10 pounds is equivalent to a pressure or pull which a weight of 10 pounds produces. Weight and force, then, appear to be equivalent to each other, and so they would be but for the fact that the weight of a body varies, *i. e.*, the resistance which a body offers to being lifted is not the same at all places. It has been found that for a body upon or beyond the earth's surface, its weight decreases as its distance from the center of the earth increases. The earth is not round, and its radius is greater at the equator than at the poles, hence, a body will weigh less at the equator than at any other place on the earth's surface since the attractive force exerted by the earth is assumed to be concentrated at its center, and a body at the equator is farther from the center than it would be at the poles. The unit of force, however, does not vary, being always equivalent to that pressure which will deflect the indicator of a spring balance the same amount that the platinum standard will deflect it at the latitude of London.

Suppose a body to rest on a frictionless horizontal plane. It is evident that the very slightest force will move the body, no matter how heavy it may be, and according to Newton's first law of motion, it will continue to move forever, unless stopped by an equal force external to the body, which acts in a direction opposite to the original force. Suppose that the body weighed 10 pounds, and that it was desired to move it 80 feet in 2 seconds, what constant force (steady pressure) acting throughout the entire distance of 80 feet will cause the body to move 80 feet in 2 seconds? It is readily seen that although the slightest force will put the body in motion, it will not necessarily move it 80 feet in 2 seconds. In order to find the value of this force it is necessary to compare it with some known constant force which produces a known effect. Force of gravity, the term which is applied to the force of attraction which the earth exerts upon all bodies, is the best known example of a constant force, and is one which has been thoroughly studied, and which has been the subject of a vast number of experiments.

It was previously stated that the weight of a body varied with its distance from the center of the earth; still, for a short distance (a hundred feet or so) above the surface, the variation is so very slight that it may be entirely neglected in calculations. Such being the case, a body weighing 1 pound suspended a few feet above the earth will be attracted towards the earth with a force of 1 pound, the body having been weighed with a standard spring balance. For the movement of the body a short distance up or down, the force of gravity will remain 1 pound; hence, if the body is allowed to fall, the force of 1 pound due to the earth's attraction acts upon the body as a constant force (steady pressure) throughout its fall, and the velocity which was zero at the beginning constantly increases until the body strikes the earth. A body whose velocity is continually increased is said to be *accelerated*, and the change in velocity is called *acceleration*. If a constant force acts upon a body, it will produce a constant acceleration, therefore, for short distances above the earth's surface, a freely falling body which meets with no resistance will be constantly accelerated by the force of gravity. If the suspended body weighed 10 pounds instead of 1 pound, the force of gravity would be 10 pounds, but the rate of acceleration, were the body allowed to fall freely, would be the same as in the case of the 1-pound weight, since the force of 10 pounds acts upon a weight of 10 pounds. From this it may be stated that all freely falling bodies have their velocities accelerated at the same rate for the same latitude, whatever their weights. At the latitude of London freely falling bodies are accelerated at the rate of 32.2 feet per second every second during their fall, provided they meet with no resistance. This value 32.2 is denoted in mechanics by the letter g, and is called the acceleration due to gravity. For the latitude of New York g is very nearly equal to 32.16 feet per second.

It should now be clear that a constant force of 1 pound acting upon a body weighing 1 pound, which is perfectly free to move, will give to that body an acceleration of g feet per second every second. If the body weighed 10 pounds, a force of 10 pounds will give it an acceleration of g feet per second also. Since the value of g depends upon the force of the earth's attraction, a little thought should make it evident that this fact affords a means of comparison for ascertaining the effect which a given constant force will produce upon any body of known weight. To make this clear, suppose that a body were to weigh 1 pound at the latitude of London, and that by some means the force of gravity were to be doubled, the body would then weigh 2 pounds, the value of g would also be doubled and the acceleration due to gravity would then be $32.2 \times 2 = 64.4$ feet per second. Also, suppose that the force of gravity could be decreased until it was only half as great, the body would then weigh only ½ pound on a standard spring balance, and the value of g would be only $32.2 \times \frac{1}{2} = 16.1$ feet per second.

In either of the last two cases, were the body resting on a frictionless horizontal plane, a constant force of 1 pound would produce an acceleration of 32.2 feet per second, no more, no less. This should be apparent since the force of gravity would have no effect in causing or retarding motion if the body rested on a frictionless horizontal plane; and since the force of gravity may be assumed to increase or decrease indefinitely, the strange anomaly is presented of a constant force of 1 pound producing a constant increase in the velocity of a certain moving body, no matter what its *weight*, of 32.2 feet per second every second that it acts. From this, the conclusion is irresistible that weight is not and cannot be an unvarying measure of the amount of matter that a body contains, *i. e.*, it is not a property of matter, since in the above cases the same body weighed 1 pound, ½ pound and 2 pounds. The conclusion is also arrived at that a constant force acting on the same amount of matter will always produce the same acceleration whatever the weight of the body.

The absolute (unvarying) measure of the amount of matter that a body contains is the quotient obtained by dividing the weight of a body (determined by means of a standard spring balance) by the value of g at the place where the weighing was done. Ap

plying this rule to each of the three cases cited above, the amount of matter contained in the body is: $\frac{1}{32.2}$, $\frac{2}{64.4}$ and $\frac{\frac{1}{2}}{16.1}$, all of which are equal to $\frac{1}{32.2}$. The quotient thus obtained is called the mass of a body, and so long as the same quantity of matter remains in the body its mass never changes, provided the units of weight and acceleration are not changed.

To express the value of the mass of a body by means of a formula, let W = the weight of a body and m = the mass, then:

$$m = W \div g. \qquad (1)$$

If the British system of weights and measures are used, the value of W must always be taken in pounds and the value of g in feet per second. If the value of W were taken in ounces and g in miles per hour and these values were substituted in formula (1), the chances are that the value of m would be widely different from its true value; hence, it is necessary to reduce the ounces to pounds and the miles per hour to feet per second before substituting in the formula. If this be done, the value of m (the mass of the body) will always be the same when the body is weighed with a standard spring balance.

It was previously shown that a body whose mass was $\frac{1}{32.2}$ and which ordinarily weighed 1 pound, would weigh 2 pounds if the force of gravity was doubled. It was also shown that if this body were free to fall the constant force acting upon it would be 2 pounds, and the resulting acceleration would be 64.4 feet per second. In other words, doubling the force acting on the same mass doubles the acceleration. In the same manner it can be shown that halving the force of gravity halves the constant force acting upon the body and halves the acceleration. In the first case, the constant force is 2 pounds and the acceleration is 64.4 feet per second, and in the second case the constant force is $\frac{1}{2}$ pound and the acceleration 16.1 feet per second. From this it is easy to see that multiplying the mass of the body by the acceleration gives the constant force, since $\frac{1}{32.2} \times 64.4 = 2$ pounds and $\frac{1}{32.2} \times 16.1 = \frac{1}{2}$ pound; moreover, since any combination similar to the above will give similar results, it follows that if the mass of a body be multiplied by its acceleration in feet per second, the result will be the constant force which gave the body that acceleration. Letting F = the constant force in pounds,

$$F = m\,a. \qquad (2)$$

The formula for finding the acceleration when the distance passed through in feet, and the time, are given, is:

$$a = 2\,s \div t^2; \qquad (3)$$

in which a is the acceleration in feet per second, s is the distance passed through in feet, and t is the time in seconds.

Applying formula (3) to the example given near the beginning of this article, s = 80 feet, and t = 2 seconds; hence, $a = 2 \times 80 \div 2^2 = 40$ feet per second. The mass of the body is $\frac{10}{32.2}$, and the constant force required to move it 80 feet in 2 seconds is $\frac{10}{32.2} \times 40 = 12.422$ pounds.

The acceleration of a body moving through 1 foot in 1 second is $a = \frac{2\,s}{t^2} = \frac{2 \times 1}{1^2} = 2$ feet per second, and the force required to move a body weighing 1 pound through 1 foot in 1 second is $m\,a = \frac{1}{32.2} \times 2 = \frac{1}{16.1}$ = .0621 pound, nearly.

J. J. CLARK.

Scranton, Pa.

The Purchasing Agent Nuisance.

Editor American Machinist:

Recent and appropriate remarks in your paper concerning the purchasing agent, move me to remark that he is a nuisance wherever he is found, particularly in the gear business.

Example 1.—I got an order from a purchasing agent of a large company for a lot of gears, to be "of best possible quality," as he expressed it. No price was asked, and I made the gears from best steel and phosphor bronze, and planed in the bevel gear teeth; that being the best I knew as to quality. Sent in, with bill. Shortly got a "kick," saying that a duplicate of the order was at the same time sent to another maker, and his bill was about half mine. I investigated and found that the other maker used common composition instead of phosphor bronze, cast-iron instead of steel, and chopped out the teeth as rapidly as possible. I stuck to my price, was told that my bill would not be paid, and had to threaten suit to get my money. I was just aching to sue for it, for the fun of it, but the P. A. never fights.

Example 2.—Got a "blue print," with request to estimate cost. Blue print specified dimensions of the "college graduate" sort, pitch diameter 4.67352 inches, teeth to be just so deep and so-and-so, without the slightest regard to standards in use. I asked the parties to come down to standard pitch, and was informed that my advice had not been asked, but that my estimate alone was required. I don't know who made those gears, but he had a job of it. If there is anything in this wide world that is a little smarter than anything else, it is the fresh, young fellow who has just graduated from some polytechnic institute. It is hard work rubbing common sense and practice into him. He is a little better than the "self-made" man when he has been hustled about for a year or two and has had some of his mathematics shaken out of him, but at first he is a trial. I have been there myself, and the amount of book knowledge I have forgotten is large.

Example 3.—Got a "blue print," without information as to material required. Asked, and was told to make it of steel or cast-iron, "as may be the cheapest."

These, and numerous other practical examples of the purchasing agent, have taught me to estimate at least 50 per centum more in such cases than where the work is laid out and managed by some hard-handed mechanic who knows that there are gears and gears; that steel costs more than cast-iron to work, although it costs less to buy in the rough; that rawhide will not "outwear steel," and that the lowest price seldom means the cheapest product.

Lexington, Mass. GEORGE B. GRANT.

Cast-iron Pulley Arms.

Editor American Machinist:

Having had over 25 years experience making and using machinery and tools, I feel that I can criticise Prof. De Volson Wood, page 483, where he says: "This is especially the case where light parts join heavy parts. Thus in a pulley, if the straight arms join the rim at right angles, as at *a* and *b*, the arm being the lightest will cool first, and by contracting pull away from the rim, making a crack at *a* and *b*."

Some of us old heads had a controversy through the AMERICAN MACHINIST fourteen years ago, in regard to shrinkage in pulleys, and I am certain that cast-iron shrinks to-day very much as it did in 1881.

I believe I have never seen a pulley with heavy rim and light arms break while cooling. I have, however, seen a good many broken arms in pulleys with light rims, in comparison to the thickness of metal in arms and hub.

I have witnessed a few cases where the arm pulled off with a snap from the comparatively thin rim, while the pulley stood on the machine shop floor ready to be bored. Some of us know that straight cast-iron bars can be bent into letter S when carefully handled at the proper heat—which is a dull red; to be too hot would be as disastrous as to be too cold.

My partner and I once accepted a small engine lathe with 8-foot bed, in payment for a debt of $25. The lathe had passed through a fire the previous day, and was hanging down like a hammock, though perhaps not quite so much. I think about three-quarters of an inch.

We brought that lathe bed within one-sixteenth of an inch of straight, with fire, and afterward planed it. About fifteen days' time was put on the lathe, and it was sold for $250 to machinery dealers in Chicago, who never guessed it had been through a fire.

This may seem like digression from the subject, but wait. I know that an iron casting at a certain heat is very pliable, and can be readily bent. Pulley arms are often much thicker than the rim, and the hub is necessarily heavier than the rim. Pulley arms may be straight and thin, and no danger of breaking while cooling. When a pulley arm breaks while cooling this is what takes place: The rim being the thinnest part of the pulley, it cools quickest, compressing the softer arms and hub somewhat. Afterward the hub and arms are losing their heat more rapidly than the rim, because at this time hotter, and are also becoming very rigid, and every part is now too cold to stretch, consequently a longitudinal strain is created in the arms which often amounts to more than the arm can resist, and it pulls apart at its lightest part, which is near the rim.

It is the part which cools last which does the mischief. It is the same way in hardening tools.

J. E. MCCONNELL.

The Angle of Projection.

Editor American Machinist:

I have read the various articles on the proper method of projection which have appeared in this paper, since Mr. Spaulding brought up the subject, and I think that uniformity of practice is desirable. In the first angle of projection, the object to be drawn is placed above a horizontal plane which we will consider as the plane of the paper; an imaginary vertical plane is then placed *behind* the object at right angles to the horizontal plane; points from the object are then projected upon the horizontal plane (as they would appear to the eye if placed above the object) and connected by lines; this view of the object is called the plan. Then points from the object are projected upon the vertical plane as they would appear to the eye if placed in front of the object; the vertical plane is then turned back around its intersection with the horizontal plane until it is even with the plane of the paper, and we have the front elevation above the plan. If it is required to make right and left-hand side views, a vertical plane is placed at the right of the front elevation, and a view of the left side of the object is projected upon it; it is then turned to the right until it is even with the plane of the paper, bringing a view of the left-hand side of the front elevation at its right. For a view of the right-hand side of the front elevation a vertical plane is placed at the left and turned back around its intersection, towards the left, bringing a view of the right-hand side of the object at the left of the front elevation. And similarly, if a bottom view of the object was required it would be placed above the front elevation.

In the third angle of projection, the object to be drawn is placed beneath the horizontal plane, and behind the vertical; suppose these planes are transparent. The top view of the object is then projected upon the horizontal plane, and the front elevation upon the vertical; the vertical plane is then turned around its intersection with the horizontal bringing the front elevation below the top view. To get the right and left-hand side views of the object, vertical planes are placed to the right and left, and turned around their intersections, bringing a view of the right-hand side of the object at the right of the front elevation, and a view of the left of the front elevation to correspond, and if a bottom view was desired it would be placed at the bottom. It will be seen that if we have an arrangement of views drawn in the first angle of projection, and wish to arrange them according to the third angle, we could transpose the arrangement of views around the front elevation, bringing a view of the right at the left, the bottom at the top, etc.

The purpose of a drawing is to show what is wanted, and it is essential in order that the drawing may not mislead, to know just how these planes are turned around their lines of intersection. Now, if the views are arranged as in the third angle, all a workman needs to do to understand the drawing, is to imagine the paper folded at right angles between any two adjacent views, and imagine the object placed opposite these views, and he will have a correct idea of its form to work from. If the views are arranged according to the first angle, he would need to know how the planes are turned, and then it would be doubtful if he gets along as well as if the views were arranged according to the third angle. I prefer the third angle of projection, and as it seems to be the best arrangement of views for machinists to work from, I think it should be adopted.

J. T. G.

Bolt Tension.

Editor American Machinist:

In Professor Wood's second article on "Machine Design," in the AMERICAN MACHINIST for June 13th there occur one or two statements which do not seem to me to be quite correct, and coming from so great an authority as Professor Wood, they are all the more likely to mislead.

The chief of these is in his calculation of the number of bolts to hold the cylinder head on, in which he deducts from the 10,000 pounds per square inch, which he allows for the safe tensile strength of wrought-iron, 4,000 pounds *for the stress due to screwing up the nut.*

I think this matter was all threshed out in the AMERICAN MACHINIST some five or six years ago, but perhaps it is permissible to recall the principle of the matter. This is that *a bolt is elastic and acts just like a coiled spring.* The further it is screwed up the greater the tension put upon it, *because it has to stretch further.* If the bolt, cylinder head and flange were all absolutely rigid and inelastic (which no material of any kind whatever is), the nut could be screwed up just as far with the fingers as it could with a four-foot wrench, once the cylinder head were shoved into place

Tightening up the nut with a wrench is precisely the same as screwing down the spring of a safety valve, it puts the "initial tension" on both, and no more reduces the safe effective strength of the bolt in the one case than it reduces the pressure at which the spring would take a permanent set in the other.

In order that the cylinder-head joint may not leak, the initial tension on the bolt must be *greater* than the pressure which the steam will put upon it, for if it is less the bolt will stretch further under steam pressure and relieve the pressure which the spring of the bolt puts on the joint, so allowing the head to leave the flange and leakage to occur, just as the safety-valve spring is further compressed and the valve forced from its seat when the pressure of the steam exceeds that of the spring.

It is evident, therefore, that instead of deducting the initial tension from the safe strength of the bolt to obtain the capacity of the bolt to resist steam pressure, this capacity depends first of all upon the initial tension of the bolt, which in turn may be anything within the safe strength. It is surprising also that Professor Wood, in writing upon the thickness of the cylinder flange, after rejecting the calculation for strength as insufficient, should not speak of the importance of having the flange thicker than the head, so that in case of breakage it will be the cylinder head rather than the cylinder which will go, and also of the importance of having the flange *stiff* enough on account of making the joint. With the flat-face joint shown by Professor Wood this is especially important, the more so that he advocates setting the studs so far out that the tap will come through clear of the cylinder wall, which would seem less important than having the stud as close as possible to the place where the holding is to be done.

J. E. JOHNSON, JR.

The Piston-rod Explosion.

Editor American Machinist:

When I read the account which you quoted from the *Sibley Journal of Engineering*, of the explosion of a piece of a piston rod, and your comment on it, it recalled an incident which happened several years ago. In heating a 5-inch steel shaft belonging to a tug boat, when at a red heat, it exploded, the opening in one side being about 1½ inches by 6 inches. A slight flaw in the end of the shaft indicated that it was "piped," and as the shaft had been constantly submerged, it was decided that the water had entered this flaw, but for some reason was unable to escape, and the steam pressure caused the explosion.

WM. MERRILL.

Saginaw, Mich.

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☞ *We publish nothing in our reading columns for pay, or in consideration of advertising patronage. Space in the advertising pages only is for sale.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Every correspondent, in order to secure attention, must give his full name and address; not necessarily for publication, but as a guarantee of good faith.*

☞ *All communications for, or relating to the reading columns should be addressed to the editor. All other communications to the company, as above.*

☞ *Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

☞ *The* ***American Machinist*** *is not interested in any particular patents, products or factories, to the prejudice of others, but is devoted to the interests of all those who have to do with designing, building, selling and using machinery.*

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WM. D. MAHANEY, Correspondent.

NEW YORK, JULY 11, 1895.

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Enforce the Rules or Amend Them.

We think it is probable that the meetings of the American Society of Mechanical Engineers are at least as well managed as those of any similar society. Its officers and members are for the most part men who have had special training in the art of managing affairs, and fully appreciate the importance of directed, orderly and systematic procedure. The fact that they are so, while it in one way helps those who have charge of the society's affairs, in other respects makes their position more difficult, because the standard of attainment in this respect is higher than it otherwise would be.

The rules of procedure which have been adopted by the society respecting the presentation of papers and discussion upon them, while they are probably not perfect, yet have been adopted, we know, as a result of very much and very careful study, and, of course, with no other object than to secure the best possible results for the greatest possible number of members. There have been a few criticisms and objections to some of these rules, but we are quite certain that the vast majority of the members, especially of those who have given the matter any attention, believe that they are wisely conceived, that they promote the best interests of the society, and of most of its members. For this reason we think it is a matter for regret that they should be practically abandoned or ignored, as they were at Detroit.

Stated briefly, the rules provide that all papers to be presented at a given meeting shall be prepared and submitted in time to get them in type three weeks before the time of the meeting. It is expected that every member who intends to be present at the meeting will receive printed copies beforehand, and will familiarize himself with such of them as he is specially interested in or wishes to discuss. This makes it unnecessary that papers should be read in full, and the rules, therefore, provide that abstracts only shall be presented, and that not more than five minutes shall be allowed for the presentation of any one paper.

Regarding discussions of papers, the rules provide that, where a member has reduced his discussion to writing, he may have ten minutes in which to present it, but that extemporaneous discussion shall be limited to five minutes for each speaker, and that no speaker shall claim the floor the second time until all who wish to speak upon the subject have had an opportunity to do so. Not a single requirement of these rules was observed during the recent meeting. One member spent at least half an hour in what was virtually an extemporaneous address upon a range of subjects more or less remotely connected with the subject of his paper, which he was supposed to be presenting by abstract, and in discussion each member spoke as long as he thought he had anything to say, and took the floor as often as he chose, seldom even waiting for recognition by the chair, or seemingly to think of observing either the special rules governing the society, or the common rules supposed to govern all deliberative bodies.

For some time past there has been too much laxity in the matter of accepting and presenting papers not received in time to be sent out to members in advance of the meeting, thus preventing their previous study as contemplated by the rules. In the case of this last meeting this mistake was avoided; papers received too late were held over for presentation at a future meeting, and those accepted were sent to members in time for study and preparation of discussions. Under such circumstances, nothing short of the repeal of rules by the society justifies their abandonment during a meeting, and no member has a right to object to their courteous but firm enforcement; while all members who attend have a right to expect that rules adopted deliberately and in the interest of the membership generally, will be observed by all members and enforced by the presiding officer.

Not every one can abstract a paper well. A man may be the best living authority on the subject of which he treats, may write an excellent paper upon it and yet fail in an attempt to present briefly its essential points. The secretary of the society by much practice, and probably also by reason of some natural adaptability for it, has become an expert in abstracting. He can, within the prescribed limit of time, skip through a paper, pick out its salient points and present them in such a manner as to bring the subject fairly before the meeting; and there are those who think it would be a gain if it were made a regular order that he should present all papers. In lieu of this, which would be objectionable on some accounts, a good plan would be, we think, to require each author to present with the manuscript of his paper an abstract of it to be passed upon by the publication committee, printed with the paper and read by its author or the secretary in presenting it. This ought to lead to the best possible presentation by abstract in most cases, and if printed along with the paper would certainly add very much to the value of the volumes of published proceedings, by making their contents much more convenient for quick reference when studying the literature of any certain subject.

The entire abandonment of restrictions upon the time taken by members in presenting and discussing papers would reduce the number of papers possible to be considered at any one meeting, and, of course, much reduce the range of subjects treated, which, it seems to us, is not desirable. All the members are not equally interested in all subjects connected with mechanical engineering, the rules provide that the minimum of time required for the proper consideration of each paper shall be devoted to it by the society as a body and yet give ample opportunity for each individual member to give any paper he may choose such fuller study as may seem to him desirable.

We believe they are admirable rules; that the society should see that they are reasonably enforced, or make such changes in them as may seem desirable to the majority of the membership.

The Vertical Shaper.

It is a rather singular fact that the more recent progress in the development, improvement and wider application of machine tools has been in the line of machines in which the cutting tool moves, and the work is fixed, rather than in those where the tool is stationary and the work moves. The lathe and the planer have perhaps just held their own, while the shaper, the milling machine, the boring machine, the drill, the grinding machine have each achieved a pronounced advance. We may reasonably expect that the line of progress will continue for some time in the same general direction, and if we wish to help things along we can hope to accomplish the most by shoving in the way that things are moving. There is one machine that to-day seems to be lagging behind in neglect and unappreciation, yet which is certainly deserving of better treatment, and capable of valuable service if intelligently and appreciatively directed. We mean, of course, the machine indicated by the title above—the vertical shaper or slotting machine. There are a great many shops of considerable size without a slotting machine, and many others where it is admitted as a necessity for some special line of work only. This ought not to be so. Merely changing the name of it as we suggest ought to help it along and give it a better chance. The vertical shaper is capable of doing a large share of the work done by the horizontal shaper, without the inconveniences of the latter machine. If we ever want to cut anything the first condition to be insisted upon would seem to be that we should see where we were going to cut and what we were cutting. With the horizontal shaper this is almost an impossibility. You cannot see the front of the work where the cut begins. It is impossible to lay out lines upon work to be planed to an irregular shape, and then to work to the lines, because you cannot see them. This difficulty was recognized in the draw-stroke shaper. The slotting machine offers a better opportunity for seeing precisely what is being done than any other machine, and it is almost unaccountable that it should be so neglected. There is something apparently wrong and out of gear, when the band saw can become so quickly the pet of the wood worker, while the vertical shaper is so despised and neglected by the machinist. It has been neglected not only by the users of machines, but also by the improvers and inventors of machines, and that may be what has kept it back. Anything has only to stand still to be away behind in a short time. If man has ever invented a perfect machine of any kind it is to be found among the dead ones, and not among those that are alive and active to-day.

The swindler, R. D. Uhthoff, is still in business at the old stand, 106 Hanover street, Baltimore, Md. H. E. Hawes, Machinist, 393 Pearl street, this city, sends us a letter dated as above, June 18th, asking for catalog, price list, discounts, etc.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(271) S. D. L., Winchester, Cal., writes: Kindly inform me what kind of tool steel is most generally used by nail manufacturers for their board nail (wire) pointing dies. *A.*—We are not aware that any particular make of tool steel is generally used for these dies. Write to steel manufacturers, and state the purpose for which the steel is to be used, and you will undoubtedly get a satisfactory quality of steel.

(272) W. J. G., Drifton, Pa., writes: Kindly recommend a book treating on the strength of materials, one that is not full of calculus. I do not care about the price, but want it to be simple and plain. *A.*—"Textbook on the Mechanics of Material," by M. Merriman, and "Design of Structures," by S. Anglin. Both of these are good and as simple as can be made compatible with the importance of the subject.

(273) B. F. G., Reading, Pa., writes: During the last winter months you published an article showing the method of laying out a pattern for a bonnet with a circular top and rectangular base. I would like to have the paper which contains this article; can I still obtain this paper, and what will it cost? *A.*—The article to which you refer was published in our issue December 20, 1894. We can supply any of last year's numbers at the regular price of 6 cents per copy.

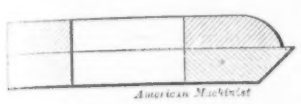
(274) M. S. B., Belfast, Ireland, writes: Kindly give me the dimensions, including horse-power, etc., of the American liner, "St. Louis." *A.*—All dimensions of this vessel which we have been able to obtain are given in our issue of July 4th, current volume. 2. In what direction do twin screws of steamers revolve—in, or outward? *A.*—Twin screws are usually made to turn outward, in order to avoid the risk of floating objects becoming jammed between the upper blades and side of vessel. There are vessels in which the screws turn inward.

(275) C. A. J., Boston, Mass., writes: Please give name of a good book treating on boiler making, giving plain and simple rules for finding the length of a sheet before it is rolled, how to get the number of tubes and stay bolts, pitch and size of rivets, a book that will treat on all the details, and one suitable for a young man. *A.*—"Plating and Boiler Making," by a foreman patternmaker, may suit you. It may be said here that a knowledge of mensuration and of the simpler problems in geometry will be of great aid to you. It is advisable for you to take up these studies, for which use the books like those adopted in the public schools.

(276) J. R. B., New Iberia, La., writes: We have a stern wheel boat with two high-pressure engines, one on each side, the cylinders are 8 inches diameter and 36 inches stroke. We would like to know if it would be feasible to take one of the high-pressure cylinders out and replace it with a low-pressure one. The engine[illegible] 17 feet apart. What diameter should [illegible] low-pressure cylinder be? We use [illegible]n pressure of

100 pounds per square inch. *A.*—It is quite practical to change the two single expansion engines into a compound engine, by taking out one of the cylinders and replacing it by one 14½ inches diameter. In making this change careful attention must be given to all the details, and unless you are familiar with the construction of compound engines we should advise you to secure the services of an experienced mechanical engineer.

(277) C. A. T., New York, asks: What will prevent moldings from being pitted as they are run through the machine? We have trouble of this kind; we have the same trouble whether we use the blower or not. Our molding machine runs at a speed of 3,700 revolutions per minute. *A.*—There are two methods for preventing this trouble; one is to fit a scraper or doffer and fasten it in the machine between the cutters and the



feed roll. The other is to fix a cap on the tool or cutter similar to the cap on a hand plane bit something like that shown in the accompanying sketch, leaving as little projection beyond the cap as possible. This method is to prevent the chips clinging to the edge of the cutter, and pitting the surface before arriving at the place where the doffer is located. A powerful blast projected onto the right spot should drive the chips away, but they would be scattered so that it would be difficult to collect them.

(278) A. B. E., Philadelphia, Pa., writes: Please give me a rule for balancing a slide valve by means of rectangular strips bearing against a surface above the valve, such as are frequently used in locomotives. The steam ports are 1¼x16 inches; exhaust port, 2¼x16 inches; bridges, 1 inch wide; outside lap, ¾ inch; inside lap none; steam pressure 180 pounds per square inch. *A.*—The area on top of valve which is not exposed to the steam pressure, measured from outside to outside of strips, should be ⅝ of the area of the face of the valve. The strips should be 1¾ or 2 inches deep; the latter dimension is the better one if it does not contract the exhaust cavity in the valve too much, and ½ inch is about the proper thickness of the strips. The strips are held up by spiral springs; these springs are made of steel, sometimes of hard brass, the diameter of wire ranging from $\frac{1}{16}$ to ¼ inch. Sometimes the strips are held up by elliptic springs, one being placed under each strip. If helical springs are to be used, two for each short strip and five for each long strip will be sufficient for this size of valve. When new, the strips should not project more than $\frac{1}{16}$ inch above top of valve.

(279) Qinte, Glenora, Canada, writes: Water is discharged through a pipe 72 inches diameter under a head of 180 feet, how many cubic feet of water will be discharged per minute? *A.*—The discharge will depend on the length of pipe and the roughness of the interior surface of the pipe. Since the length of the pipe is not given, we shall use for finding the velocity of flow the following formula, which gives the velocity through an orifice:

$$v = \sqrt{64.4 \times h};$$

in which v = velocity of flow per second, and h = head in feet. From this we get:

$$v = \sqrt{64.4 \times 180} = 107.6 \text{ feet}$$

per second. The cross-sectional area of a pipe 72 inches in diameter is 28.27 square feet; multiplying this area by the velocity we get the discharge in cubic feet per second; hence we have:

$$28.27 \times 107.6 = 3{,}041.852$$

cubic feet per second, or

$$3{,}041.852 \times 60 = 182{,}511.12$$

cubic feet per minute. 2. How much power can I obtain from this flow? *A.*—The energy of this moving water, or the work which it is capable of doing, is the same as that stored up by a body falling freely under the action of gravity through a hight equal to the head. Let W be the weight of water per second passing any cross-section of the pipe, and K the energy, then from the above we have:

$$K = W \times h. \qquad (1)$$

Now, the weight W, that is, the weight of water discharged per second, is equal to the discharge in cubic feet per second multiplied by weight of one cubic foot of water, which we shall take to be 62.5 pounds; hence:

$$W = 3{,}041.852 \times 62.5 = 190{,}115.75$$

pounds, and the stored-up energy according to formula (1) is:

$$K = 190{,}115.75 \times 180 = 34{,}220{,}835$$

foot-pounds, and the horse-power due to this stream is:

$$34{,}220{,}835 \div 550 = 62{,}219$$

horse-power. This is the theoretical horse-power; in practice about 60 per cent. up to 90 per cent. of this will be realized. 3. What is the loss of head when the power is drawn off? *A.*—That depends on the friction in pipes and the manner of applying the energy. 4. Please give name of a good practical book on hydraulics. *A.*—"Treatise on Hydraulics," by M. Merriman.

(280) B. J., ——, Wash., writes: I recently took charge of a low-pressure steam boiler which had been idle about a year. I found it half full of water, and removing the manhole cover and going into the boiler I found what seemed to be grease spots on the water line and below it, and also on the tubes; on touching these spots I found a thin shell over them, and in breaking the shell a dark-colored water would run from under them; after washing the spot it became bright and the iron was badly eaten away as deep as ⅛ inch in some places. The boiler was used for heating purposes, and the water due to condensation was returned to it; feed water was also taken from the river, but no grease was used in the boiler. Please state if this is a case of ordinary pitting and give remedy. *A.*—This is evidently a case of pitting. In many boilers fed from one source and the water containing sulphate of lime a coating of oxide of iron of a black color may be found adhering to the detached scale, which as often as it re-forms and is broken off brings with it a fresh film of oxide. This form of corrosion is most capricious in its attacks. It may be found on every plate of a boiler in contact with the water, and sometimes in the steam spaces and domes; or it may be found only on a single plate either above or below the water line, whilst the remainder bear no traces of corrosion. The mysterious manner in which pitting occurs, and its peculiar character, have not yet been satisfactorily explained. The concentrated acids of the water will attack the most susceptible portions of the plates. Whether the plates in the steam space are attacked or not will depend upon the nature of the acids, whether they are volatile or not, or whether the liquid acid is carried into the steam space by priming. However, pitting is caused by impurities in the water; hence the surest way in your case, of preventing this internal corrosion, is to abandon the use of the water taken from the river, and use the city water. When this cannot be done the simplest way of preventing the corrosion, in many cases, is to neutralize the acidity by treatment of some alkaline substance, either prior or subsequent to the introduction of the water into the boiler. This is best done by using soda, soda ash, or caustic soda, which should be dissolved and constantly introduced with the feed water rather than in doses of long intervals. The quantity required will vary according to the strength and quantity of the acids in the water. However, care must be taken in using these substances, when strong saline solutions are formed in the boiler, as in using salt water the introduction of soda will be found to be an evil, and the only remedy in this case is to keep down the strength of the solution by frequent blowing off from bottom and surface. We should advise you to have the water analyzed and thereby determine the suitable alkaline substance to use, or the best course to follow.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 554.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

American packing rings are in touch with the cylinder. New circular about rings and pistons. J. H. Dunbar, Youngstown, O.

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The Manufacture of Power.

Man has now learned to *manufacture power*, and with the manufacture of power a new epoch began. I use the words advisedly. Creation, whether of substance or force, is not given to man; manufacture is not creation; but to change inert matter from one form to another in such a way as to generate power, is to manufacture power.

Furthermore, not only does the manufacture of power mark a new epoch in development, but the change is greater than any which preceded it; greater in its influence on the world; greater in the results which are to come.

The manufacture of power means that wherever needed we can now produce practically unlimited power; whatever the measure of a single machine that machine can be used to make a greater one. We are no longer limited by animal units, confined by locations of water-falls, or angered by the uncertain power of wind. Power can be had where it is needed and when it is needed; the manufacture of power has enabled us to concentrate in the hull of a single ship twice as much force as is developed by the whole water-power of the Merrimac at Lowell, and this is but a trifle of what may be done.

The new epoch differs from all preceding epochs in that, while they represented successive periods of progress, different races have existed simultaneously in every period of advancement, whereas the new epoch must from its nature soon become universal. The manufacture of power has given us the means of traversing the entire globe with a regularity and speed which brings all races together, and which must in time remove all differences in capacity. It brings people of all races into contact, and by extending knowledge, ends the superstitions and mysteries which have had such influence in the past. It enables man while working in unhealthy districts to spend a portion of his time in places favorable to physical health and bodily vigor, and so may end the climatic degeneration of race, which has done so much in history. It is gradually breaking down national divisions, substituting the natural boundaries of convenient government for boundaries based on race and ignorance. It will finally make the human race a single great whole, working intelligently in ways and for ends which we cannot yet understand.

It is not too much to predict that when the full effects of the manufacture of power are realized, and the world has passed through the development which the next ten centuries will see, the time when man began to manufacture power will be recognized as the division between the ancient and the modern, between ignorance and intelligence, between the national strife which may then be classed as barbarism, and the new civilization, whatever that may then be called. . . .

The new epoch has barely begun, no exact dates can be fixed, epoch making is not a matter of a single invention, it is the general result which follows. It was not the manufacture of the first earthen pot, but the general introduction of pottery, which carried a prehistoric race from savagery to barbarism. It was not the invention of a few letters, but the general use of a written language which took the barbarian into civilization. It was not the invention of the first steam engine, but the general control of the manufacture of power which is now taking mankind into the new civilization. James Watt developed his first steam engine in 1769. The steam engine began to come into general use about the beginning of this century. The nineteenth century has seen the development of the manufacture of power by steam. The steam engine is still almost the sole representative of manufactured power, but there is no reason why this should continue. Electricity as a conveyer of power has been developed to an extent which may almost be classed with manufactured power. New forms of manufactured power may come at any time, but the introduction of new forms is a comparatively unimportant thing, the great advance came with the ability to manufacture power at all; the method is a secondary thing.

. . . . In a distant part of the world a railroad is building which cannot fail to have a great influence in the new epoch. Twenty-six years ago the American continent was first crossed by a railroad reaching from ocean to ocean; seven years hence the Trans-Siberian Railroad will complete a continuous line across the older and greater continent, eastward instead of westward, from the Atlantic to the Pacific. This new railroad, passing around the most populous portion of the globe, and the seat of a civilization now farther than any other from the conditions of the new epoch, may do more than any one thing to render that epoch universal. In about a century from its first general introduction, manufactured power will have crossed both continents, and by the aid of manufactured power on the ocean it will be possible to make the circuit of the globe in about 40 days. . . .—*George S. Morison, C. E., Annual Address as President of the American Society of Civil Engineers.*

Various Causes of Boiler Explosions—II.*

BY WILLIAM HENRY FOWLER, WH. SC., ASSOC. M. INST. C. E.

COLLAPSE OF BOILER FLUES.

It is shown mathematically that any deviation from the cylindrical shape seriously weakens a boiler flue, and Sir W. Fairbairn has shown that the length of a flue is also an important factor in estimating its resistance to collapse. Most boiler flues have strengthening rings, and either welding or double butt straps take the place of the lap joint. In practice the collapse of a flue nearly always consists of a flattening of one or two sides. Generally the top of the furnace gives way, the crown of the tube is crushed down, following approximately the sweep of the lower portion. This case is most common because the crown is most affected both by the fire and by corrosion. Sometimes the bottom of the flue is crushed upwards, the crown remaining convex, and sometimes the sides are crushed. Fig. 12 shows a typical collapse in small vertical boilers, and similar effects occur in vertical chimney boilers, whose flues should always be strengthened by hoops.

COLLAPSE OF FURNACES.

Overheating Through Low Water.—Whatever the cause of low water the effect is always the same, the furnace crowns are exposed to the weakening influence of an increasing temperature and they bulge down. Such collapses usually occur in only one furnace of a pair, as the fires are not charged simultaneously. These collapses are not generally as serious as those above mentioned, and the author remembers but one case in twenty years where low water in a Cornish or Lancashire boiler led to the destruction of the shell. The risk of serious rupture in case of collapse from overheating is much reduced if the tube is strengthened by encircling rings, and cases have occurred where these rings have averted serious tearing.

Precautions should be taken against low water, the chief one being duplicate water gages, so that one may check the other, and valuable supplements to the gages are the low-water safety valve and the fusible plug. Water has been accidentally run out of a boiler by the blow-off cock being opened. Such cocks should have a safety guard to prevent the removal of the key unless the valve was closed. With several boilers fed from one pump differences of pressure, especially if a check valve sticks, will siphon the water from one boiler to another, and feed pipes supplying a group of boilers should deliver 3 or 4 inches above the furnace level.

* From the Proceedings of the Institution of Civil Engineers. Condensed by and for the AMERICAN MACHINIST.

Whatever the cause of the overheating the character of the collapse is practically the same and with the same local peculiarities. In the Lancashire boiler both furnaces will usually show marks of overheating—a purple bloom on the fire side of the collapsed part showing the extent of the overheating, and if this has been excessive it is corroborated by discoloration on the water side, but seldom to the same extent. In some tests by the Manchester Steam Users Association, under a pressure of 40 pounds, the water level was lowered by opening the blow-off until nearly half the circumference of each furnace tube was bare. The time occupied in exposing an arc of the tube having a versed sine of 15 inches, was 4 minutes, and 6 minutes after, or in a total of 10 minutes, 1 tube collapsed. The heat attained was not known, but it is reasonably certain that the furnace became red hot. Gages attached testified to the rapidity with which the collapse occurred, and observation showed that with a large surface quickly exposed to heavy fires there is very little warning, and when bulging begins complete collapse is only a matter of a few seconds.

In a later test the crowns of the furnace tubes were laid bare by evaporation, as low water in a boiler generally occurs, and some fusible gages were attached to give an idea of the temperatures attained. The water was first brought down to the top of the furnace crown by using the blow-off which was then closed and the fires were heavily charged. In 23½ minutes, all the fusible gages having melted, the feed delivering 28 gallons per minute was turned on through a perforated pipe delivering the water in fine jets upon the overheated plates. The only effect was to reduce the pressure, which fell in 2½ minutes from 28½ pounds to 26 pounds. The whole bearing of these and other tests showed that the popular notion as to turning on the feed when the water is low is erroneous.

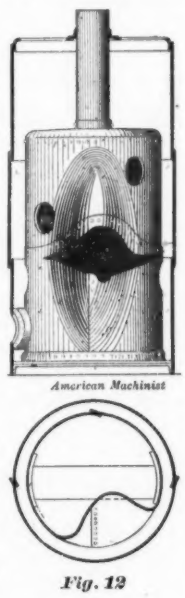


Fig. 12

Failures on account of low water are not confined to Lancashire or Cornish boilers, Collapse of locomotive boilers sometimes occurs, but they have better attention, the roofs of their fire boxes are better supported and can give better warning before the danger becomes serious. The furnace tubes of multitubular marine boilers sometimes collapse through overheating, but in these cases it is not from a deficiency of the water supply.

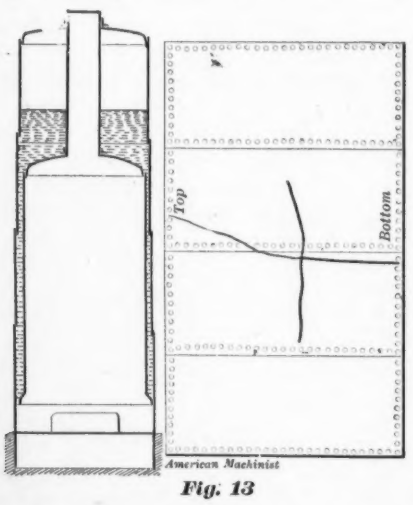


Fig. 13

In small vertical boilers low water generally causes collapse and rupture of the uptake before the water is low enough to expose the fire box; although, as the uptake is also a stay, when it gives out the collapse of the furnace crown may follow. In plain egg-ended boilers the water may fall very low without serious overheating, and the straining and leakage will warn of the danger. Explosions of such boilers have occurred, however. One of these showed discoloration on each side over the fire, indicating that the water had been boiled down to a depth of 6 inches, when the left-hand side ripped for a length of 4 feet 6 inches and 2½ inches wide in the middle, with distinct lips on each side, showing that the rupture was produced while the plate was in a plastic condition. This case by the absence of water showed how water is the main factor in the work of destruction. The contents of the boiler consisting almost entirely of steam it escaped through the opening as from a fractured pipe, and the boiler was not stirred from its seat. An equal rupture with the water at its normal level would probably have completely destroyed the boiler and surroundings.

Cases of overheating and rupture often result from the presence of soluble salts, mechanical impurities, grease, etc., in the water, and sometimes from imperfect circulation due to faulty design. In marine boilers with a copious supply of water and a fair factor of safety the neglect to blow off results in saturation and a deposition of salt, which as a bad conductor of heat soon interferes with its transmission so much that the plates can soften and collapse under ordinary working pressures. In some vertical boilers the overheating shows most at the bottom of the fire box which bulges inwards all around and forms pockets at the level of the grate bars. In land boilers the carbonates and sulphates of lime and magnesia are the most frequent cause of overheating, especially if grease is also present. High-pressure marine boilers using fresh water from surface condensers have had trouble from the grease carried over from the engines. The overheating from the above last mentioned causes is very gradual in character as compared with the overheating from low water.

Fig. 13 shows how overheating may occur as a result of defective design and inadequate circulation. This is a vertical boiler in which the annular water space surrounding the fire box was exceedingly narrow, being only from 2 to 3 inches for a depth of 9 feet 6 inches. The water space was too narrow, and when the boiler was crowded the upcast current of steam interfered with the down-flow of the water, the fire box was surrounded by foam rather than by water, and the plates were overheated. The boiler gave trouble from the first, and bulges or pockets began to form inside the fire box at the fire level. Stud stays were inserted across the annular space to prevent the pocketing, but they were not a success, and the fire box eventually collapsed and was torn from top to bottom. Overheating from a similar cause often occurs with some types of sectional tubular boilers. Taken as a class the employment of tubular boilers is not desirable when the water is heavily charged with lime salts or other impurities.

Over Pressure.—Explosions from pressures ranging above the working pressure are always associated with defective safety valves. The safety valve is defective if it can be overloaded by accident or design, or if it may be possible to jam it down by the insertion of a wedge or block, or if the spindle can rust fast in the cover. Valves of the dead weight type are much better than lever valves. The grouping of the safety valve and the stop valve upon a common outlet, especially if the boiler be one of a series, is to be avoided on account of the ease with which the hole may be plugged on the inside and pass undetected. Two very disastrous explosions have occurred from this cause.

Faulty Material and Construction.—In an explosion of a Lancashire boiler which occurred within six months after being set to work, the nature of the fracture showed that the plates had been partially cracked along a line of rivet holes in one of the longitudinal seams. The plates were of "Best" iron (which, as is well known, is of poor quality), and the holes were punched before the sheet was bent. Mild steel has now generally taken the place of inferior iron, and the plates are generally drilled after bending. Gross carelessness of construction was shown in another case, Fig. 14, where a boiler shell burst from over pressure, the seam which gave way having at first been punched wrong and subsequently punched again along the same line, and the defect covered by an iron angle bar. In both of these cases a hydraulic test would probably have revealed the defective work.

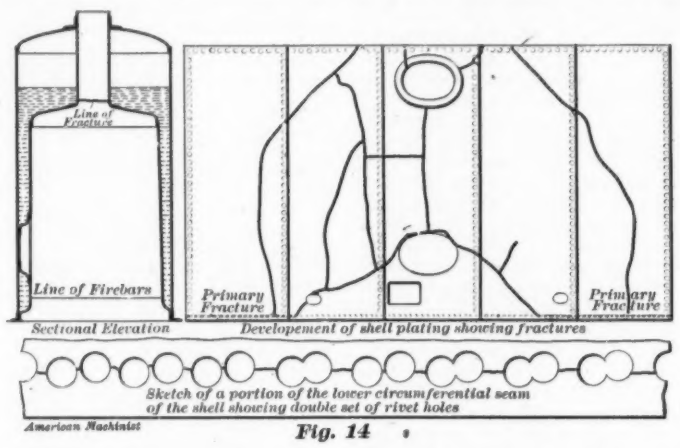

Line of Fracture
Line of Firebars
Primary Fracture
Primary Fracture
Sectional Elevation
Developement of shell plating showing fractures
Sketch of a portion of the lower circumferential seam of the shell showing double set of rivet holes
American Machinist

Fig. 14

The facts and statements contained in the above paper have been collated in the course of a somewhat unique experience.

The Band Saw.

BY JOHN M. RICHARDSON.

A band saw will saw probably four times as fast as a jig saw, and it works quite as smoothly, requiring no blower to keep the sawdust away. The jig saw has the great point in its favor that it is able to do inside work, so if possible have both a jig saw and a band saw, but if one only can be used take the band saw every time.

On pattern work, to saw a place having no connection with the outside, simply saw boldly in on a straight line until the inner design is reached, then saw around it, and draw the work away from the saw by means of the cut first made. Now glue in a thin piece of wood the width of the saw kerf, and when the pattern is finished it will not show if black shellac is used.

It is possible (although not always convenient) to do anything by means of a band saw that is commonly done on a circular saw, except rabbeting and dadoing pieces that are over a foot or 15 inches in length, so if it were not possible to have more than one saw for ordinary machine pattern work, the band saw would be the last to be parted with, because it covers the widest range of usefulness.

I am a champion of the band saw, for it is a noble tool when properly treated, but if not the results are poor enough, for no machine tool will realize its capabilities without proper attention. A band saw should be kept sharp, with enough set to prevent its binding on a curve, and no straggling, ragged teeth which are worse than dull ones. It is also necessary to have the saw properly secured between guides to ensure precision.

The breakages are caused oftener than any other way by crowding stock against a dull saw, or by suddenly wrenching it sideways. Very frequently a saw about to break will give a warning thump every time the weak tooth passes through the work. When this sound becomes too pronounced, it is better to stop the machine and remove the saw, breaking it by hand before again using. A saw that thumps generally has the weak spot where the joint was brazed. No one can predict, as a general thing, when a break will occur; the unexpected often happens, and sometimes when the machine is started up the blade will snap before the workman even touches it with the stock, and also sometimes when the shipper rod is shifted to stop the saw, the blade will break before the workman reaches his bench. This is apt to happen when a saw has been used for a long time.

An even tension of the blade is an important point. Some saws are provided with an index to register this, while others are not, and the workman turns the hand wheel which tightens the blade by guess, and the saw is at the mercy of the man's muscle, probably never being strained to exactly the same tension two successive times. Anyone not acquainted with band saws when entering the pattern room and looking at one, is almost sure to ask, "Do they ever break?" and when being answered in the affirmative, the next thing is, "Do they hurt anybody?" the idea in their minds seeming to be that they would wind around one like a python in case of a breakage. This idea is erroneous. There is not one chance in one hundred of being hurt, but it is a decidedly startling sensation the instant the snap comes, and it makes one jump.

I have seen many saws break, but was never even scratched save once, and then only slightly on the fingers. When the snap comes, it instantly releases all tension and also any onward motion of the saw, the ends simply throwing themselves outwards and seldom scratching one. If the wheels are not rightly adjusted the blade will not keep its proper position as it revolves, and I have known a saw to fly off the rims a number of times when in motion without breaking. Once one came off in this manner and encircled the workman as it dropped. This is a rare instance, and the man was, of all things, little expecting to be lassoed by a band saw.

The knack of folding saw blades is hard to catch, even when watching one do it, if it is done quickly. If done slowly, and one watches carefully enough to remember each motion, it can be acquired quite easily. Whether a person who has never witnessed it can accomplish it from any description of mine, is a question I will not try to answer.

Grasp the saw in both hands, at about arm's length, standing where there is plenty of room, and having the blade resting on the floor about a foot and a half from the feet. Now take one step backwards, at the same time bringing the arms together until the hands are about a foot apart. The saw is now divided into four curves, which we will call *A*, *B*, *C* and *D*. Curve *A* points downwards, in front of the body, and *C* also in the same direction, resting on the floor. *B* points upward, and is governed by the right hand, and *D* exactly the same, only governed by the left hand. Now try to do three things at once: bring the hands together, so that curve *B* will cross curve *D* above it, and curve *D* take the same relative position in the opposite direction beneath it, while curve *A* is folded under them both. Now drop the whole affair directly over curve *C*, which rests upon the floor, and the saw is folded into three circles, ready to hang up. This is the common number of folds used, and they should not be increased unless for the purpose of getting the saw into a small compass for shipping purposes.

A saw can be brought into a very small compass, namely, nine circles, by taking it folded as just described, and considering it now as an entire saw, next folding it again, following the same movements on a reduced scale. This is quite difficult to do.

A better way to increase the folds above three circles, is to hold the folded saw in the left hand, and with the right pull the blade out into one large loop, still retaining the folds in the left hand, and proceed as at first, only, of course, it is on a reduced scale, and throw the circles in the left hand in together with the others at the instant the saw is dropped.

A person can fold a band saw just as small

as he wishes by following these same movements over again for a few times.

The ends of the saw for brazing must lie each upon the other, similar to the lap in an endless belt, and should each be filed back for the distance of two teeth, and then the saw placed in the brazing clamps. Do not have any two adjacent *half* teeth, as we might express it, come together pointing in different directions as to the set, but before filing the joint, take one end of the saw in each hand and place them by each other the length of two teeth, and notice if the bend in each tooth in the joint comes properly. If not, break or cut off one tooth from one of the ends, and then the trouble will be remedied.

Brazing clamps are furnished with band saws, and simply serve to hold the saw in position while being fastened. After giving the final turn with the thumb screws, be sure that the under edge of the saw is exactly in line where the joint comes, and then proceed with the brazing. This can be done by using thin sheet brass, silver solder, or coin silver, and probably with other substances also, and acid or borax can be used in connection with them, together with hot blacksmith's tongs or a brazing lamp. For materials I would advise silver solder and powdered borax, or if silver solder is not convenient to procure, take a 10 cent piece and pound it out flat on an anvil until it is quite thin, say, 1¼ inches in diameter or more. Now take a piece of the silver about the size of the lap, and moisten it, together with the halves of the joint; cover the solder with powdered borax, and the joint, also, both inside and out, and place the solder carefully between the overlapping ends of the saw. The moisture makes the borax stick nicely. Next apply heat.

If tongs are used, they should have thick ends or jaws and should be brought to rather more than a red heat, that is, bordering on a white, and the joint should be nipped by them for a moment, until the solder flows freely, and then be carefully removed so as not to open the laps. Next sprinkle water over the brazed part, so that the joint will not be too soft. A little practice in this is needful, for if too much water is dashed on when the joint is still red hot, it will make it so hard that there will be trouble in filing, but if this should happen, it is very easy to hold the saw over a flame and draw the temper.

A good brazing lamp is much neater to use than tongs, and will save a journey to the blacksmith's forge to do the heating, and also the carrying of saw and clamp as well. In whatever manner the saw is brazed, the heat ought to be concentrated just as much as possible on the joint, so as to prevent its spreading, for heating the saw will not do it any good. If a joint is nicely made the saw should break in any other place just as readily when the time comes.

After the soldering or brazing just described, the joint must be filed and the excess of solder removed, and be sure that the blade at this point is no thicker than at any other. I consider a band saw about as easy a saw as I know of to file, and at the same time about as tedious. The teeth should be filed square across, both on back and front, and the front should be slightly angling or hooking, so that the saw can take hold of the work to the best advantage. Machine filers and setters are now coming to the front, and a really good one is an actual necessity, in a shop employing many men, simply in the time saved, but for the benefit of those who prefer to do it in the old way, I can say that I doubt if the actual results are much better than by careful hand work.

Chicago to Buffalo by Fifty-foot Steam Yacht.

PATROL BOAT FOR HARBOR POLICE.

The city of Buffalo, N. Y., awarded the contract for their police patrol boat to the Marine Iron Works, Chicago, Ill., and delivery of this steam yacht ("Australia") in charge of Capt. Pete Larson, will be made under her own steam. She will clear from Chicago, making short stops *en route* at Milwaukee, Manitowoc, Mackinac Island, Rogers City, Port Huron, Detroit, Cleveland, Erie and Dunkirk.

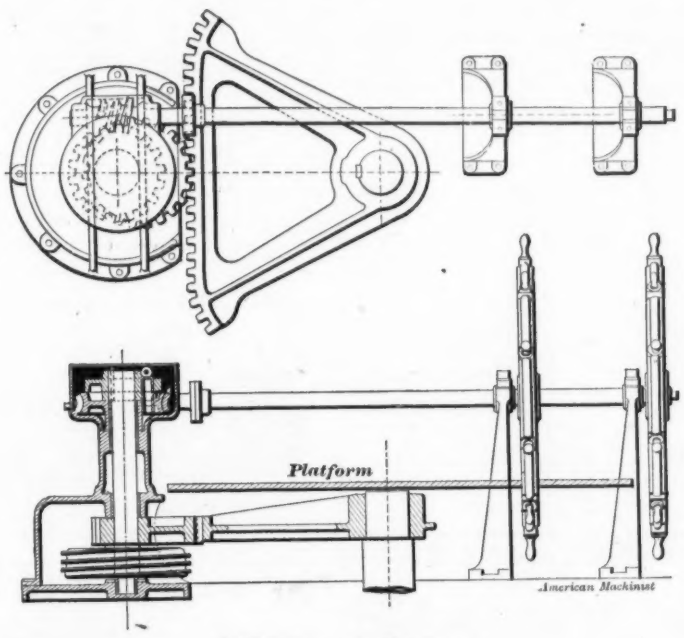
Her principal dimensions are: Length of hull, 50 feet; beam, 10½ feet; draught, 40 inches. Triple expansion condensing engine; diameter of cylinders, 4½ inches, 7 inches, and 12-inch by 8-inch stroke. Boiler allowed 165 pounds steam pressure.

The "Australia" is a handsome, seaworthy craft, a credit to her builders, and those interested in steam yachting should make it a point to inspect her, although, as prompt delivery is contracted for, she will only remain at the above ports over night.

Captain Larson is keeping a carefully written up log as to the incidents of the trip, showing the time made, the consumption of fuel and supplies, and other items that would be of interest to steam yachtsmen.

A Novelty in Gearing.

For the interest of our readers we reproduce from *The Engineer*, London, illustrations of a novel hand-steering gear recently applied to three steamers of the British and Colonial Steamship Company. The horizontal shaft with the steering wheels upon one end has a worm upon the other end operating a vertical shaft which carries an eccentric pinion, and this works into the compensating rack head upon the top of the rudder stack. It will be readily seen that this arrangement secures a greatly increased leverage upon the rudder as it is put over in either direction. The spiral rope wheel upon the lower part of the vertical shaft is for auxiliary or preventer steering ropes if the hand wheels should be carried away. The steam-steering gear is attached to the rudder shaft upon the deck below.



A NOVELTY IN GEARING.

Ten Thousand Men Benefited.

The E. P. Allis Company recently made a voluntary raise of 10 per cent. in the wages of their workmen, numbering from 1,600 to 1,800. It came as a pleasant surprise to them, and they celebrated by raising the flags over the works. This brings wages up to the old scale. All the leading iron works are now on the old footing, and orders are coming in that promise to keep them busy at fair profits. Probably 10,000 men in this city have had their wages raised, or the time increased, so as to even up within the last month or two. This is evidence from a source that the men can appreciate that business is improving. It is all the better that it has been in all cases voluntary, as with the Allis Company. This is really the best feature of it, because it improves the relations of the workmen and their employers, and indicates that the advance is not drawn out grudgingly and with danger to the prosperity of the works, but on a safe basis. It betokens a confidence long wanting in the business world. —*The Milwaukee Journal.*

Electricity on Elevated Roads.

The Lake street "L" of Chicago are, as they claim, to be the third elevated railway system of the world to be operated by electricity, the first and second being the World's Fair road and the Metropolitan road of Chicago respectively. The contract for the electric equipment of the Lake street road has been awarded to the General Electric Company. It is stated by General Manager Bernard E. Sunry that the cost of motors and electric apparatus will be $100,000, and the total cost of the system will be twice that amount. The Lake street system is now operated at a cost of $300 per day, which expense will be reduced by the new system. Five dollars per train per day is saved in the substitution of a motorman for the engineer and fireman. There will be less noise and no smoke.

Order for Heavy Steel Beams.

An order has just been received at the Homestead Steel Works for 37,000 tons of the heaviest beams ever rolled. They are for the New York elevated railroads. Several were turned out in the thirty-five-inch mill, and fulfilled all the requirements of the contract, and this mill was put to work recently on the order. The beam department of the works is pushed to its utmost capacity to keep up with the orders on hand. Fifty or sixty carloads of beams are shipped daily. The tonnage for the month of June will be the largest in the history of the works.—*The Philadelphia Times.*

Literary Notes.

LIFT-MECHANISM; Theory and Review of Devices in Use. A Hand Book for Engineers, Architects and Students. By Prof. Ad. Ernst, Royal Technical High School, Stuttgart, Germany. Second revised edition. Published by Julius Springer, Berlin, 1895.

The work before us is another monument of German technical bibliography.

As far as the work of the printer and bookbinder are concerned it would be difficult to produce anything more perfect. The work is composed of two books; the text of 875 pages, with 645 illustrations, is in one, while 64 folding plates of lithographed working drawings, some of the plates containing as many as 10 separate figures, are bound in another by themselves.

The general arrangement of the book is very complete and systematic, but a frequent omission in German books is also noticed in this work—there is no index.

The arrangement of the book according to subject matter is scientific and logical, and the author claims it especially as his own.

He bases it upon the mechanism employed to obtain results, and which is of greater importance in design and efficiency than the usual division into elevators, cranes, crabs, etc., which in many cases differ only in frames or other external adjuncts.

Thus the five main divisions treat of sheaves, levers, gearing, screws and pistons, as either of these devices form the essential element of the constructor, and in this second edition the only difference in arrangement is this, that crabs with worm gears have been taken out of the division of screw crabs and are described in that relating to gearing because they approach the latter more closely in their application than those of simple screw spindles, and this arrangement makes the study of all kinds of drums possible in the same division.

The critical review of the various devices as to efficiency does not relate to the product of various shops but to the improved mechanical efficiency of devices which most careful study and experiment have made possible. Many new coefficients are given which experiment has demonstrated to be more correct than those used in the first edition.

Although the book is based essentially on European practice none of the American lifting devices are overlooked, and complete working drawings of most of them are given as well as of their modifications as now used in Europe. Frequent reference is made to all the well-known American inventions and devices, and the names of Hale, Otis, Lane & Bodley, Sprague, Moore & Pickering, Weston, Yale & Towne, Worthington (accumulator), Crane and R. H. Thorpe, are found scattered throughout the book.

There is no kind of elevator, crane, crab, hoist, winch, windlass or hydraulic jack or lifting device which is not mentioned and described in some form or other. The theory on which the various devices are based are carefully explained and formulæ given, and these confirmed by practical tests and investigations. The only subject which is not fully developed, is that of electric cranes, although there is sufficient said to show their underlying principles, and several forms are shown. Of course there is little difference between them and others operating by drum and worm gear, and hence not much need be said about them.

American builders of all hydraulic and lifting devices would do well to use this valuable work for reference, as useless experiment and waste of money would frequently be avoided were the present state of these devices as shown in this book studied previously.

ARMATURE WINDINGS OF ELECTRIC MACHINES. By H. F. Parshall, Member American Institute Electrical Engineers, Member Institution Electrical Engineers Great Britain, Member American Society of Mechanical Engineers, etc., and H. M. Hobart, S. B.

Those interested in armature windings of electric machines will find in this treatise an exhaustive treatment of the principles governing the arrangement of armature conductors for continuous and alternating currents, including various multiphase windings applicable to practice. The windings are illustrated by good, plain full-page diagrams, but in which is omitted any reference to mechanical details of construction of armature windings, since these permit of great variety, without in any way modifying the results; further, they are a part of the stock in trade of the electrical manufacturer. Each chapter commences with a general discussion of the properties of the windings treated, the explanations of the formulæ applicable, after which diagrams are given showing each useful form of winding. The treatment is so complete that windings can be designed from the information given in the chapters, but in addition to these there are 60 tables which show exactly how, with a given number of conductors, the windings have to be arranged for a given result; this will save time and labor in making special calculations. We believe that electric engineers will find this work to be a valuable and useful one The chapters treat on single-wound gramme rings; double-wound gramme rings; two-circuit multiple-wound multipolar rings; bypolar drum rings; multiple-circuit single-wound, multipolar drums; two-circuit single-wound drums; interpolation of commutator segments; two-circuit multiple-wound drum armatures; rules and tables; continuous current windings; single-phase alternating current windings; quarter-phase alternating

current windings, and three-phase alternating current windings.

These chapters take up 278 pages, and 66 pages are devoted to tables. Size of pages, 9x11¼ inches. The work is published by D. Van Nostrand Company, 23 Murray and 27 Warren streets, New York. Price, $7.50.

Doubtless an inventor might have devised a worse way of mailing manuscript to an editor than that of tightly rolling it, but doubtless no inventor ever has.

NEW CATALOGS.

We have received from the H. M. Bates Machine Co., 240 Congress street, Boston, Mass., catalog of steam engines and boilers made by them. The catalog is 5¾"x3⅜".

The M. C. Bullock Manufacturing Co., 1170 W. Lake street, Chicago, Ill., send us their catalog No. 27, 3d edition, embracing a very full description of the Willans central valve engine. The size of the catalog is 10⅛"x7¾".

We have received a pamphlet of eight pages entitled "Truths," given out by the Hogan Boiler Co., Middletown, N. Y. In this pamphlet the merits of the Hogan boiler are pointed out, and compared with other boilers from the builder's standpoint. Steam users, however, will find some interesting matter in its pages worthy of perusal.

Editor American Machinist:—Your makers of machinery suitable for our candle and stearine works will find it to their interest to send us catalogs illustrating and describing their tools. We therefore shall thank you if you will bring this under their notice. A. BOLLINCKX.
Brussels, Belgium.

MANUFACTURES

The Derby (Conn.) Lumber Co. has been organized with a capital of $50,000.

The Spades (Ind.) Manufacturing Co. has been organized with $10,000 capital.

The Lafayette Foundry Co., of St. Louis, Mo., has been formed with $10,000 capital.

The Basworth (Ohio) Tool and Supply Co. has recently been formed with a capital of $25,000.

The Greenville (Ohio) Screw Point Steel Fence Post Co. has been formed with $25,000 capital.

The Kenton Paper Co., of Louisville, Ky., has been incorporated with a capital stock of $50,000.

The Springfield (Ill.) Traction Co has been incorporated by S. W. Fordyce, with a capital of $400,000.

The Greenville Lumber Co., of Greenville, N. C., has decided to enlarge its plant double the present capacity.

The Morris Crusher and Pulverizing Co. has been organized at Cleveland, Ohio, with a capital of $100,000.

The Wisconsin River Paper and Pulp Co., of Stevens Point, Wis., will put its new mill in operation shortly.

The O'Connor Furnace and Range Co., of St. Louis, Mo., has been incorporated with a capital stock of $10,000.

The Adams (Mass.) Power Co. has been organized with a capital stock of $250,000. Chas. A. Howland is interested.

The American Signal Co. has been incorporated at Chicago, Ill., by Chas. T. Arnold and others, with a capital of $100,000.

The Trenton (Md.) Handle Co. has been incorporated by W. T. George and J. H. Shankin, with a capital stock of $10,000.

The Marshall Paper Co., of Montague, Mass., has been formed with a capital stock of $75,000. Porter Farwell is its president.

D. A. Mayers and others have incorporated the World's Safety Fender Co., at New Orleans, La., with a capital stock of $30,000.

The Consolidated Box Co. has recently been organized at Baltimore, Md., by Rufus K. Goodenow, with a capital stock of $20,000.

A new machine shop is being built by the Wayland Iron Works, at Wayland, N. Y. G G. Lewis and C. G. Van Tuyl are interested.

The Grand Rapids Pulp and Paper Co., of Chippewa Falls, Wis., will build a paper and pulp mill shortly at a cost of about $200,000.

J. L. Crowley and several others are interested in a newly organized company that is to erect a $100,000 mill at Yadkin Falls, N. C.

The Linton Coated Paper Co., of Richmond, Va., has been organized with a capital stock of $200,000. E. D. Christian is president.

At Helena, Ark., the Kaiser Lumber Co. has been organized to erect a saw-mill. R. J. Kaiser is interested. Its capital stock is $60,000.

The American Delinter Co., of Little Rock, Ark., has been organized with a capital stock of $200,000. J. H. McCarthy is interested.

The Suffolk (Va.) Saw-mill Co. has been organized with a capital stock of $48,000. R. Rowland Moore is president and general manager.

The Chattanooga (Tenn.) Implement Works have recently been organized with M. Llewellyn, president and E. H. Sholar, general manager.

The Walker Lead Co., of St. Louis, Mo., has been incorporated by I. N. Walker and H. A. Thompson, with $30,000 capital stock.

The R. McCoy Lumber Co., of Little Rock, Ark., has been organized by Geo. A. Sawyer and Edward C. Horner, with a capital stock of $125,000.

The Purity Manufacturing Co., of Little Rock, Ark., has lately been organized with a capital of $10,000. P. & T. Andersen are interested.

The West Market Street Planing-mill Co., of Galveston, Texas, has been incorporated by Wm. W. Coonradt and others, with a capital of $10,000.

The A. S. Klein Manufacturing Co., of Chicago, Ill., has been organized with a capital of $30,000. Its incorporators are A. S. Klein and W. R. Payner.

The Mississippi Valley Milling Co., of Quincy, Ill, has been incorporated by Henry A. Ritter, Edw. S. Elliott and John G. Campbell, with $100,000 capital stock.

The Amplified Electric Manufacturing Co., of East St. Louis, Mo., has been incorporated with a capital of $1,000,000, by Frederick Ulrich and John T. Dowell.

The Virginia Water and Power Co. has been incorporated at Virginia, Ill., by Geo. Conover, John A. Jones, R. W. Mills and Matt Yaple, with a capital stock of $60,000.

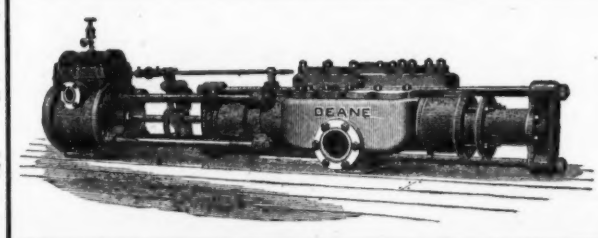
NOTICE TO THE TRADE.
MATTER OF PRYIBIL.

MACHINISTS, PATTERNMAKERS AND WOODworkers generally will please take notice that we manufacture Band Saws, Circular Saws, Jig Saws, Buzz Planers, Feed Planers, Lathes, etc., in great variety. Most of our machines have improvements not found in others of their class. We place the quality of our product above every other consideration and solicit orders from those who want machines which can be worked the hardest; which will do the most work and the best work. We have many interesting novelties, such as Straight Line Swing Saws, Stair String Routers, Sandpaper Machines for odd and crooked work, Twist or Spiral Turning Machines, Corner Block Machines, Serpentine Moulders, Bung Machines, etc., etc. Full particulars in Catalogue "A."
We also make Spinning Lathes, Buffers, Grinders, Oval Chucks, etc., for Metal Workers. These are described in Catalogue "B."
Catalogues sent Free to any Address.—Name this paper.
P. PRYIBIL,
512-524 W. 41st Street, New York City.

RECEIVER'S SALE.
VALUABLE FOUNDRY AND MACHINE PLANT FOR SALE.

The undersigned will sell at public auction on the premises formerly owned by the WHITEHILL ENGINE AND PICTET ICE MACHINE COMPANY, in the city of Newburgh, N. Y., on July 17th, 1895, at ten o'clock in the forenoon, the real estate owned by that company which came into my possession as Receiver thereof, consisting of a lot of land about 200 feet in width, and about 400 feet in depth. On this piece of real property are erected a foundry building, pattern house, blacksmith shop, machine shop and offices, all fully equipped with the necessary tools and fixtures for conducting the business of manufacturing engines, and ice and refrigerating machines.
Also all tools and fixtures owned by that company which came into my possession as such Receiver, and now on the premises and real property above described.
Also all stock, chemicals, materials and other articles of personal property, including patents, in my possession as Receiver at the time of sale.
Terms made known on day of sale.
DATED, July 3d, 1895.
ROBERT WHITEHILL, *Receiver.*
M. H. HIRSCHBERG,
Attorney for Receiver,
37 Second Street,
Newburgh, N. Y.

STEAM BOILERS,
BY
ROBERT WILSON and J. J. FLATHER.
12mo, Cloth, - **$2.50.**
JOHN WILEY & SONS,
NEW YORK.



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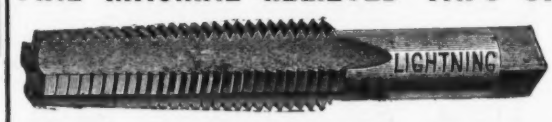
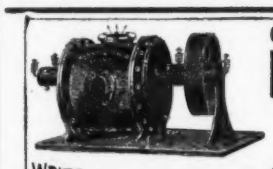
OF HOLYOKE
MINING PUMPS
The Deane Steam Pump Co.
HOLYOKE, MASS.
Write for "The Deane Specialties."

FINE MACHINE RELIEVED TAPS OF EVERY DESCRIPTION.


"Lightning" and "Green River" Brands of Screw Plates, Dies, Reamers, Tap Wrenches, Bolt Cutters, Drilling Machines, etc.
SEND FOR CATALOGUE.
WILEY & RUSSELL MFG. CO., Greenfield, Mass., U. S. A.


GARDEN CITY POSITIVE PRESSURE BLOWER
NO GEARS
SAVES 10 TO 15% IN POWER
SIMPLE — POSITIVE — EFFICIENT
WRITE FOR CATALOGUE.
GARDEN CITY FAN CO. CHICAGO ILL. U.S.A.

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

FOUR POINTS ? ? ? ?
DESIGN? WORKMANSHIP? MATERIAL? FINISH?
All these are comprised in the make-up of our lathes and are the four necessary points in the construction of a good tool. Add to these a FIFTH and a very important one, the price, which we make very low to prompt cash buyers, and you have the story.
Our catalogue will tell you all about our lathes, planers, shapers, etc. We will be glad to hear from you.
SEBASTIAN LATHE CO.,
117 & 119 CULVERT ST., CINCINNATI, OHIO, U. S. A.

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ASBESTOS SECTIONAL PIPE COVERINGS.
NON-CONDUCTING COVERINGS FOR STEAM AND HOT WATER PIPES, BOILERS, ETC.
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H. W. JOHNS MANUFACTURING COMPANY,
H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.
87 MAIDEN LANE, N. Y. JERSEY CITY, CHICAGO, PHILADELPHIA, BOSTON, LONDON

THE FINEST STEEL MADE.
Crescent Steel Co.
Crescent Special
PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.
FOR DIES AND TOOLS DOING VERY HARD WORK.

FOR REDUCING WATER PRESSURE.
We manufacture a valve to reduce the pressure from the street water main to a low pressure for houses and buildings.
LARGE DISCOUNTS. WRITE FOR PRICES.
THE MASON REGULATOR CO., 6 and 8 Oliver St., Boston, Mass.

BUFFALO BLOWERS.
UNEQUALLED EFFICIENCY, DURABILITY, MINIMUM POWER.
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

BUFFALO BLACKSMITH TOOLS.
PUNCHES, SHEARS, DRILLS, HAND BLOWERS, FORGES, ETC.
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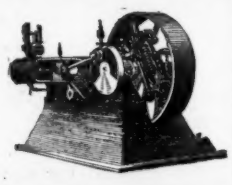
STURTEVANT ENGINES.
HORIZONTAL AND VERTICAL.
SINGLE AND DOUBLE.
SIMPLE AND COMPOUND.
SEND FOR CATALOGUE.
B. F. STURTEVANT CO.
BOSTON. NEW YORK. PHILADELPHIA. CHICAGO. LONDON, ENG.


BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

The Maysville (Ky.) Carriage Co. has been incorporated with a capital stock of $40,000. Its incorporators are J. J. Shaklefork, J. T. Fleming, J. M. Fraze and J. T. Long.

The Monmouth Cycle Manufacturing Co., of Monmouth, Ill., has been recently organized by M. C. Soule, F. E. Harding, J. H. Patter, R. Lohann and C. A. Perley, with $10,000 capital stock.

The South Freeport and Cedarville Electric Railway Co., of Freeport, Ill., has been organized with a capital stock of $100,000 by A. Bergman, Henry Lichtenberger and A. Baumgartner.

The Shurtleff Co., of Marengo, Ill., is a newly organized lumber company. Its capital stock is $20,000, and organizers are E. D. Shurtleff, J. S. Marshall, Fred. C. Jehnke and E. E. Seward.

The Peninsular Machine Company, of Grand Rapids, Mich., has been incorporated with a capital of $10,000. The officers are M. L. Fitch, president; M. Lund, vice-president and general manager, and Frank Edge, secretary and treasurer.

The Vanderman Plumbing and Machine Co., of Willimantic, Conn., have purchased the iron and brass foundry formerly conducted by Wm. Gorry deceased. Have built an addition, two stories 100x30 feet, and moved their entire works to the new plant.

The Dayton Machine and Tool Works, Dayton, Ohio, are engaging in the manufacture of special equipments for machine shops in the line of small tools, such as punches and dies, taps, reamers, gages, models and small machines. They would be glad to receive catalogs.

The Hopkins & Allen Manufacturing Co., of Norwich, Conn., are to go into the manufacture of bicycles, employing 250 men for that work. Mr. H. L. Rikard will have charge of the work and Hulbert Bros., New York, will handle the product. The bicycle will be known as "The Norwich."

The Falls Rivet and Machine Co., Cuyahoga Falls, Ohio, have secured the contract for the power transmitting machinery for the new factory of the Diamond Match Co., Liverpool, England. The order consists of shafting, ring-oiling bearings, friction clutches, steel rim pulleys, gears, etc. The Falls Rivet and Machine Co. have already fitted up several factories for the same company in this country.

Machinists' Supplies and Iron.

NEW YORK, July 6, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.25 for No. 2 Plain, and $12 for Gray Forge. Southern brands, $13.50 to $13.75 for No. 1; $13 to $13.25 for No. 2; $12.50 to $12.75 for No. 3; $13 to $13.25 for No. 1 soft; $12.75 to $13 for No. 2 soft; and Foundry No. 4, $12.25 to $12.50.

Antimony—A fair jobbing business only has been done, otherwise the market is dull, but prices remain steady. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8½c.; Hallett's, 7¼c. to 7.15c.; U. S. French Star, 7⅛c.; Japanese, 6⅞c. to 7c.

Lard Oil—Prime City we quote at 52c. to 53c.

Copper—The market is firm and inquiries are increasing. Producers hold out for higher prices. Lake Copper is quoted at 10¾c. Casting Copper, 10⅛c.; the demand is light.

Lead—The market is firm with an increased demand by consumers. Holders are now asking 3.30c. for New York delivery, and in some cases 3.32½c. is asked.

Spelter—Large orders for fair qualities are reported to be in the market, and prices have been maintained. For New York delivery 3.70c. is asked.

Tin—The market is firmer, but sales of importance are not reported. Prices have advanced to 14.20c. to 14.25c. for jobbing lots, 14.10c. net cash for round lots.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Agents traveling and local to sell steam spec'a; good commission. Mfr., 1115 State St, Erie, Pa.

Wanted—Position by draftsman with shop experience. C., care AMERICAN MACHINIST.

Wanted—Position by draftsman and designer; experience covers machine tools, electrical apparatus and heavy machinery. M. E., AM. MACH.

Wanted—Position as chief draftsman or special designer by one experienced on both heavy and light work. S. D., AMERICAN MACHINIST.

A mech. engineer with exp. designing and superintending on light machinery and stamping tools wants permanent position. Cycle, AM. MACH.

Wanted—Machinist wants position; have had experience in machine shop, also technical education. Address BOX 47, AMERICAN MACHINIST.

Wanted—A good patternmaker to work on waterwheel patterns. Apply or correspond with William Dolan & Co., Logansport, Indiana.

Wanted—First-class tool maker to take charge of tool-room in machine shop employing 150 men. Address BOX 48, AMERICAN MACHINIST.

Patternmaker and draftsman wants position in a town not more than 100 miles from New York. Address BOX 43, AMERICAN MACHINIST.

Mechanical draftsman with technical education, experienced in hoisting and general machinery, wants position. BOX 44, AM. MACHINIST.

Position wanted by a B. M. E., a graduate of the best technical school; drafting or steam engineering preferred; good references. C. G., care AMERICAN MACHINIST.

Engineer and machinist, 33, with long experience in designing and estimating machinery, desires engagement with firm needing a first-class man. O. M., AMERICAN MACHINIST.

Wanted—A competent and energetic mechanic, familiar with dynamo construction, for superintending an electric manufactory in the Northwest. Box 39, AMERICAN MACHINIST.

A thorough mechanic, good draftsman, wants position as superintendent or foreman, has held such positions; A1 reference; will be at liberty August 1st. A. H., AMERICAN MACHINIST.

Brass worker, general experience in finishing, founding, and all the metals now in use, wants a steady position at moderate salary; refs. Address G. W., 210 N. Sixteenth street, St. Louis, Mo.

All-round machinist, in present position 6 years as general foreman, a hustler, sober and reliable, wants position; west of Chicago preferred. Address BOX 46, care AMERICAN MACHINIST.

Wanted—Position as foreman or to lay out in boiler or gas holder works; 10 years' experience as foreman; A1 references. Address Box 34, AMERICAN MACHINIST.

Wanted—A competent manager for boiler works and machine shop; must be experienced and able to give estimates if required. Address F. C., 59 Liberty St., Room 16, N. Y. City.

Wanted—By a competent mechanic of large experience and who understands modern methods; position as supt., foreman or master mechanic of machine shop; best of references. E., AM. MACH.

Position wanted by a practical mechanic familiar with metal patterns, small tools, jigs, etc.; 7 years experience as foreman. Address W. W. Whitehead, 1468 Indiana avenue, Chicago, Ill.

Wanted—Position by a thorough mechanic, with necessary executive and practical experience to superintend the manufacturing of patented hardware. Address Mechanic, care J. Odell, 117 Houseman Block, Grand Rapids, Mich.

Draftsman and machinist wants position, 10 years shop experience, 2 years office experience, and 3 years in charge of a large mechanical department in Pennsylvania. Address Cambrian, care of AMERICAN MACHINIST.

Young man with 4 years' experience at tool making, and 2 years patternmaking, desires change to engine shop, marine or stationary, with chances to learn engineering; N. Y. City or vicinity. Address BOX 40, AMERICAN MACHINIST.

First-class engineer and machinist, good draftsman and expert with indicator, desires to take charge of power plant and repairs of manufacturing company, or superintendent of machine shop; well up in best modern practice. A. B., AMERICAN MACHINIST.

Wanted—A position as foreman or assistant to superintendent of machine shop by a good all around machinist, am fair draftsman, and can make a good shop sketch; at present in charge; age 32; west of Ohio preferred. Address Box 45, AMERICAN MACHINIST.

Wanted—A position as superintendent of large shop building a high grade of automatic or light machines of any description; would also consider a chance to take contracts on same with or without special tools furnished. Address "Conn.," care AMERICAN MACHINIST.

Mechanical engineer of large exp. as designer of engines, machine tools and general machinery, who is a thorough mechanic, and of acknowledged ability as shop manager, is seeking an opening with some well established concern. Box 42, AMERICAN MACHINIST.

Wanted—Constructing draftsman; must be well versed in modern machine shop methods, and able to work out ideas; ability in general mechanism or invention more essential than engineering ability; state experience, age, references. Box 38, AMERICAN MACHINIST.

Wanted—Assistant foundry foreman in a New England city; must be accustomed to light and heavy machinery and steam engine work, acquainted with the latest and best foundry methods,

(*Continued on Page 554.*)

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
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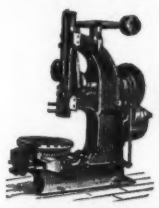
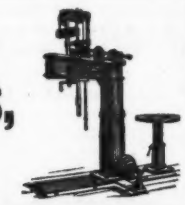
NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.



BETTS MACHINE COMPANY,
MACHINE TOOL BUILDERS,
WILMINGTON, DEL.



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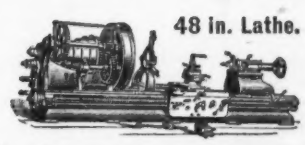
No.	INCH.	PRICE.	No.	INCH.	PRICE
1	5/16	$ .35	8	2	$1.10
2	7/16	.35	Small set of 8—5.50		
3	9/16	.50	9	2 5/16	1.40
4	1	.60	10	3	1.50
5	1 1/4	.75	11	3 1/16	1.70
6	1 1/2	.85	12	4	1.90
7	1 3/4	1.00	Full set of 12—12.00		

C. W. LeCOUNT, South Norwalk, Conn.
These goods are for sale by CHAS. CHURCHILL & CO., L'v'd, 21 Cross St., London, England.

LATHES
AND OTHER METAL-WORKING TOOLS.
Catalog E.
FITCHBURG
MACHINE WORKS,
FITCHBURG, MASS.



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New York, Robert A. Keasbey, 54 Warren Street.
Philadelphia, Macan & Co., 1420 Callowhill Street.
Baltimore, Wallace & Bro., 432 East Pratt Street.
Washington, Wm. B. Morgan, Room 19, Builders' Exchange.
Chicago, Walch & Wyeth, 208 Lake Street.
New Orleans, Delbert Engineering Co., 23 Union Street.
Memphis, Symmes & Co., 162 Front Street.
Milwaukee, Wis., F. Sprinkman, 133 Sycamore Street.
St. Louis, F. Bocler, 108 Walnut Street.

THE GREAT COAL SAVER.
Manufactured by THE KEASBEY & MATTISON CO.
CINCINNATI: 114 W. Second Street.
AMBLER, Pennsylvania.
CLEVELAND: 117 Water Street.

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Minneapolis, Arthur L. Otto, 219 South 3d Street.
Des Moines, J. C. & R. B. Carter.
Omaha, Spencer Otis, 307 S. Sixteenth Street.
Kansas City, J. H. Storer & Co.
Denver, C. W. Badgley & Co., 18th and Market Streets.
Salt Lake City, Utah and Montana Machinery Co.
Butte City, Montana, R. W. James.
Montreal, Sclater Asbestos Mfg. Co.
San Francisco, De Solla & Deussing, 2 California Street

P.H.&F.M.ROOTS,
Connersville, Indiana.
CHICAGO OFFICE:
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MANUFACTURERS OF
Portable Forges,
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ROOTS' NEW ACME HAND BLOWERS,

Slow speeded, Force blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, Etc.
COOKE & CO.
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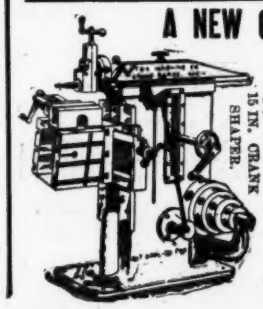

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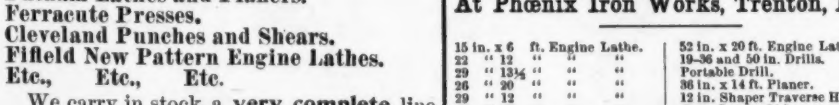

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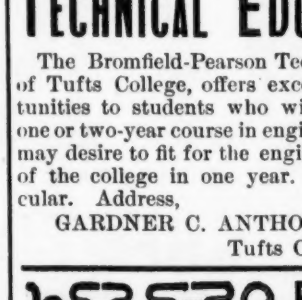

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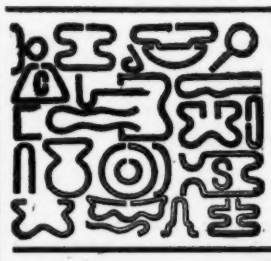

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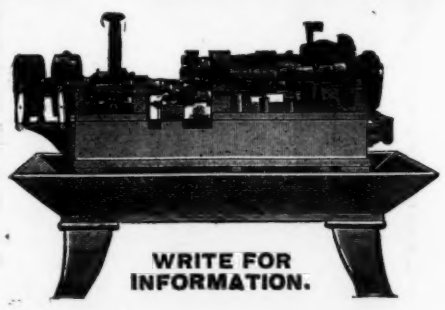

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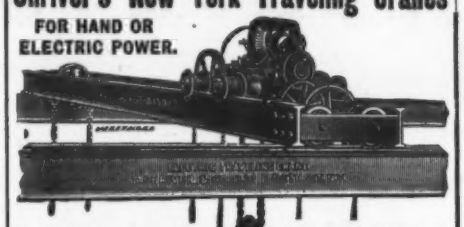

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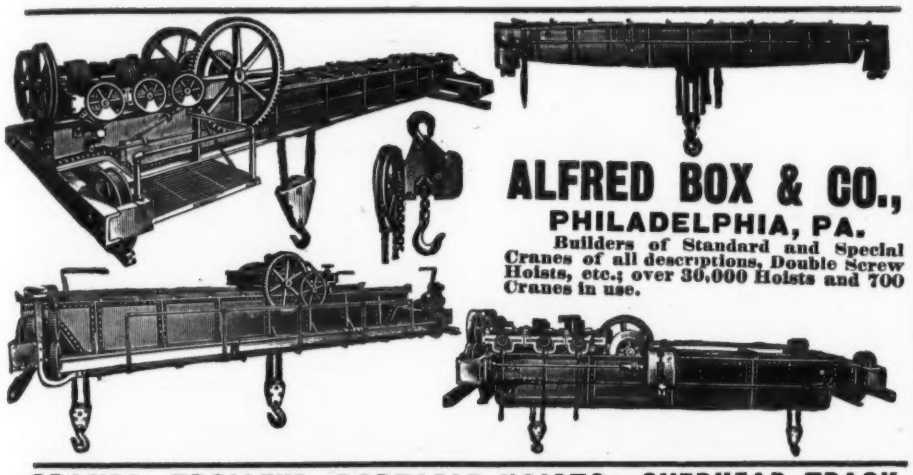

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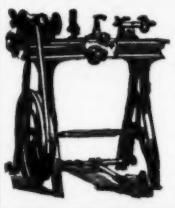

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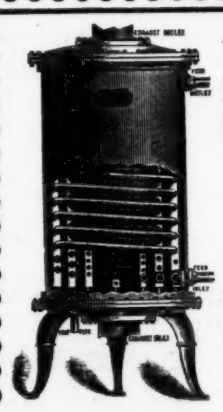

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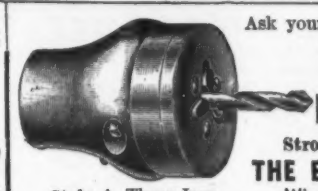

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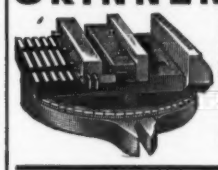

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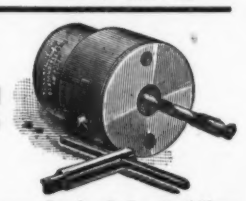

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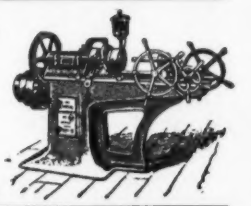

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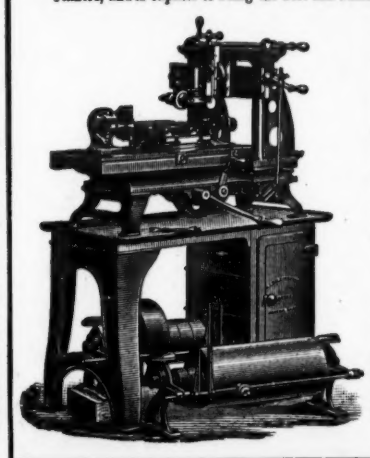

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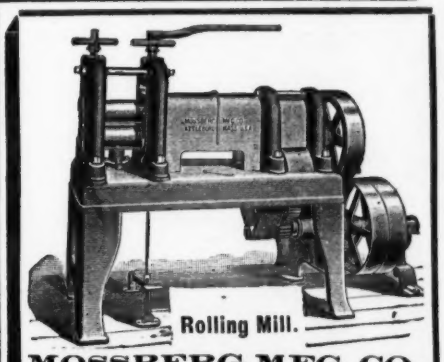

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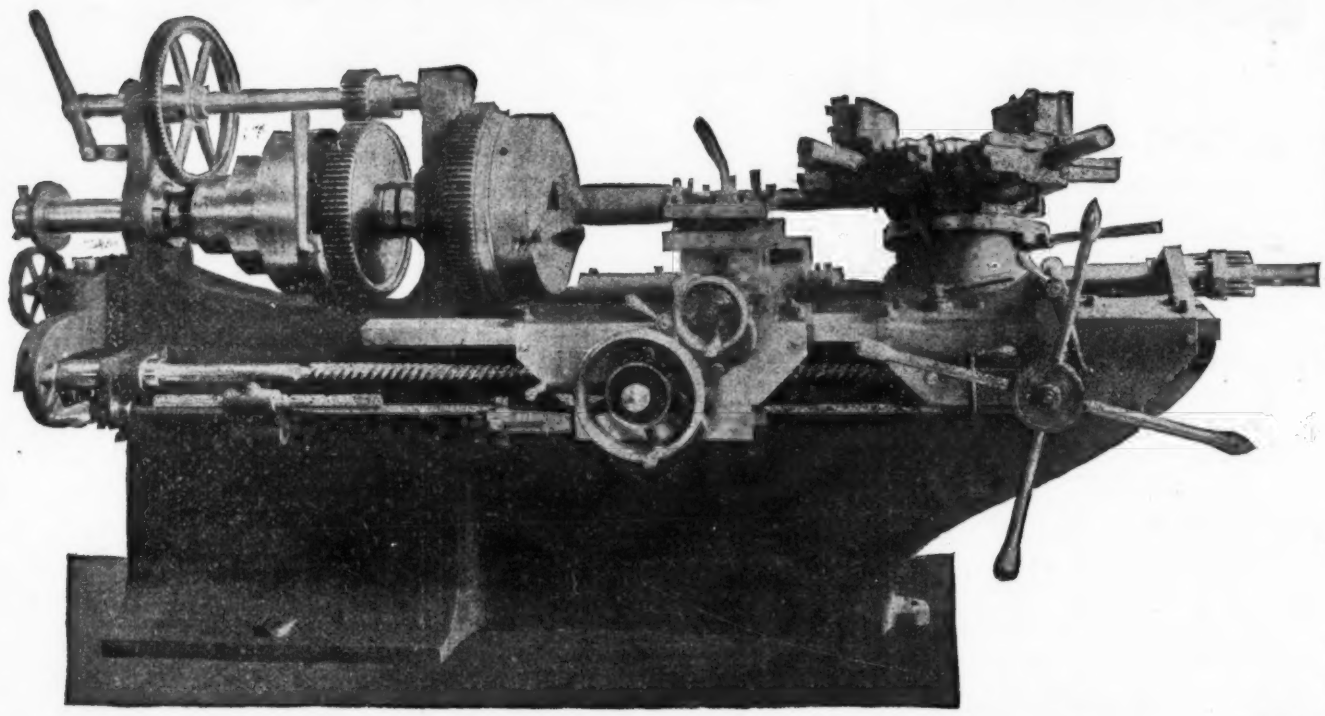

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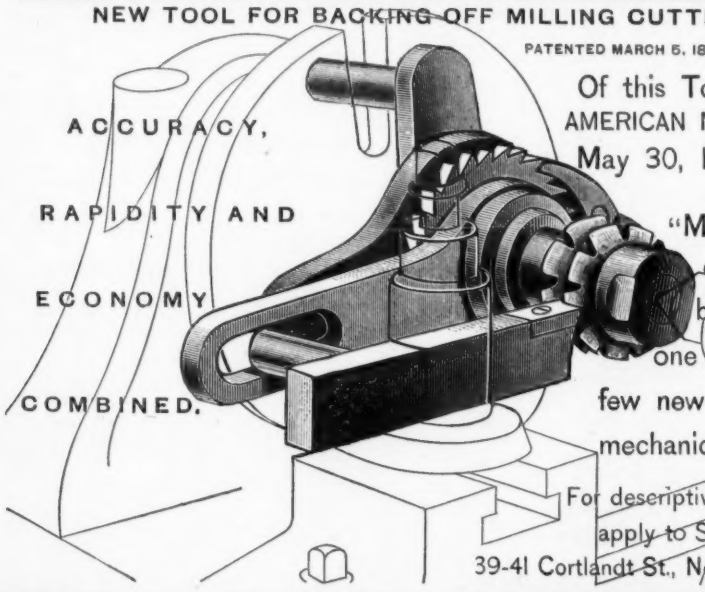

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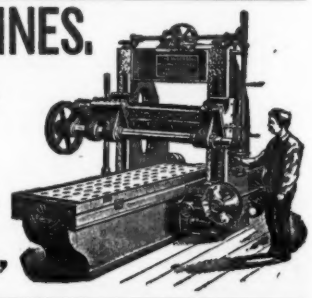

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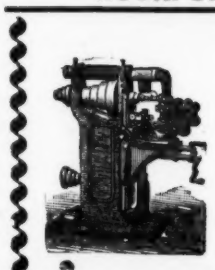

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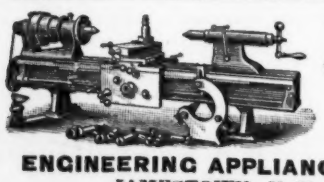

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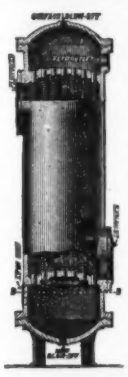

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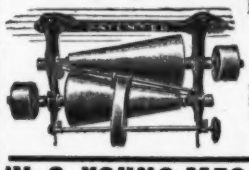

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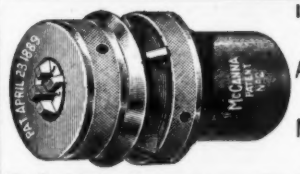

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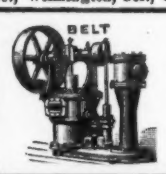

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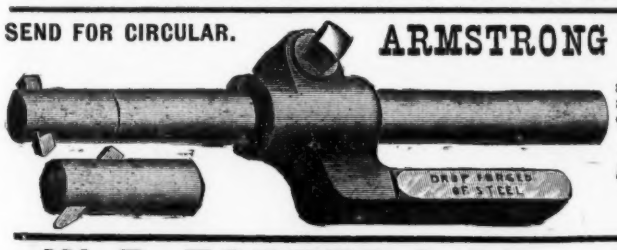

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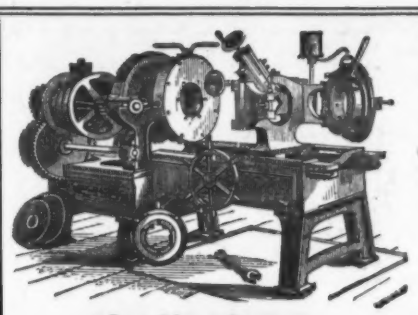

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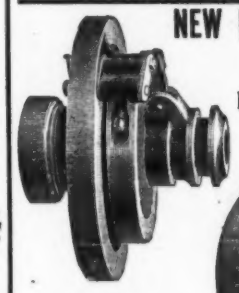

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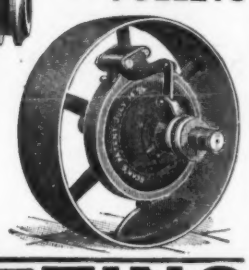

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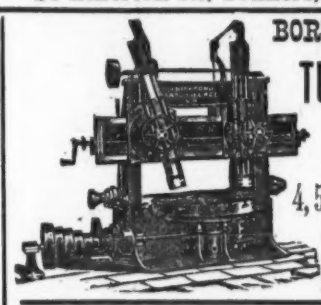

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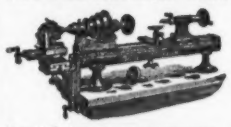

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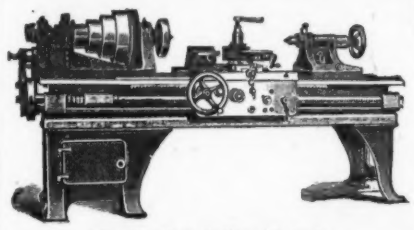

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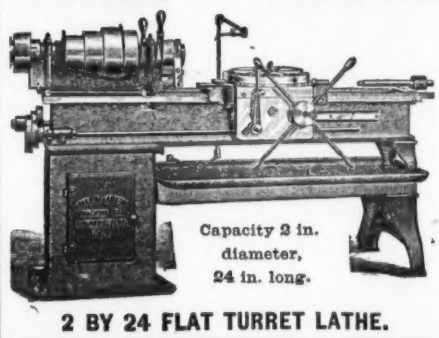

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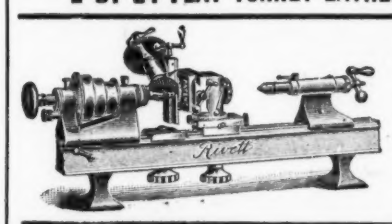

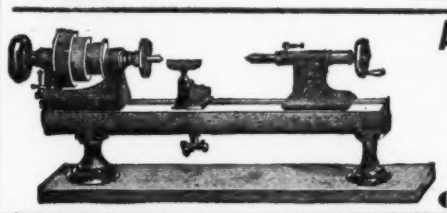

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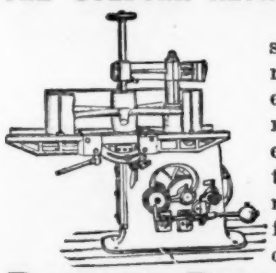

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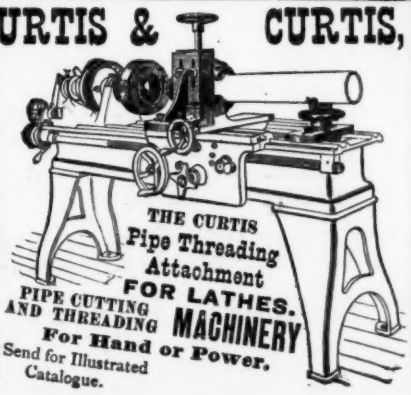

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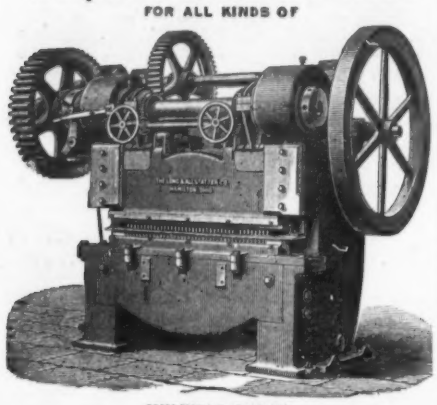

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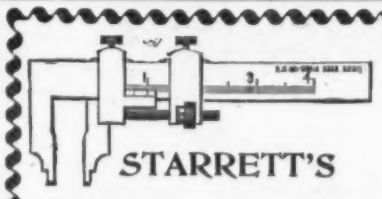

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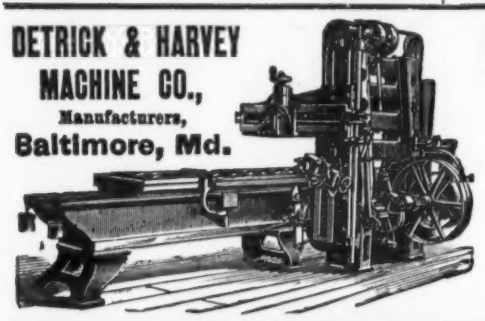

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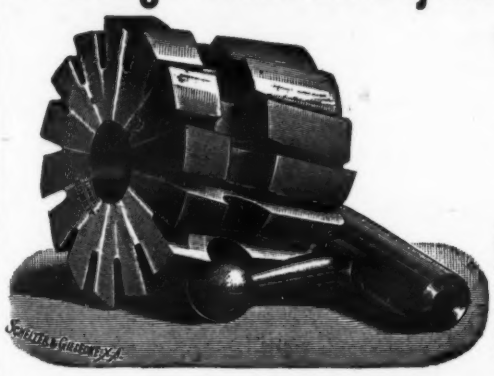

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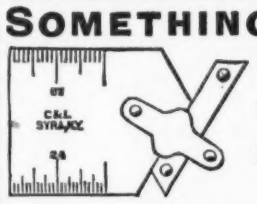

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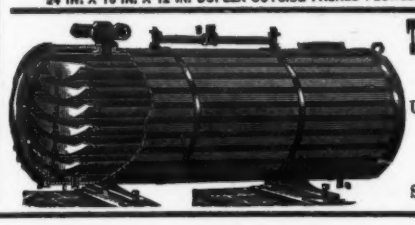

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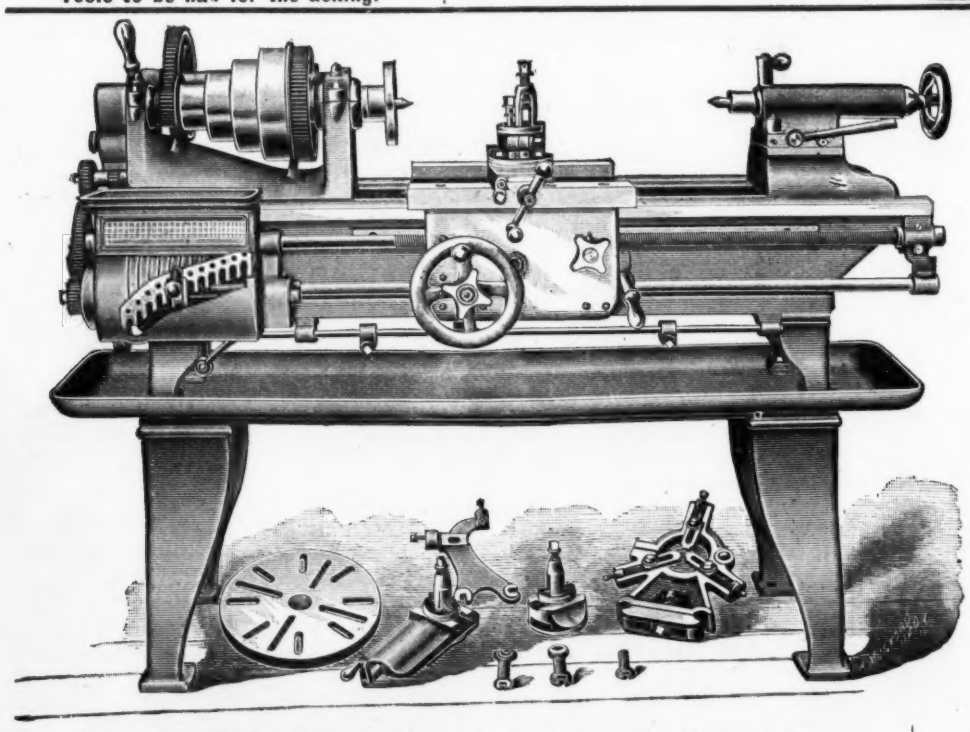

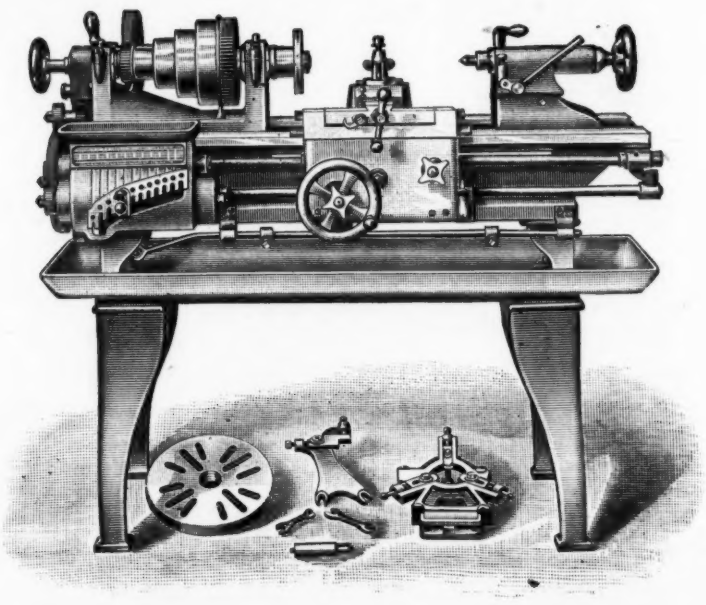

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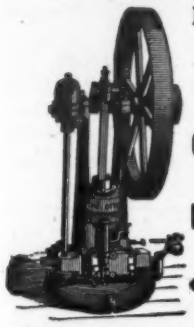

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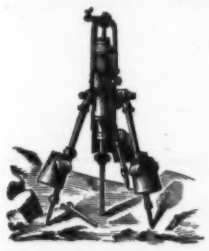

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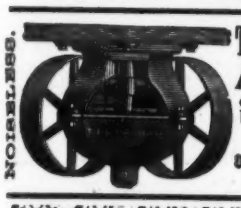

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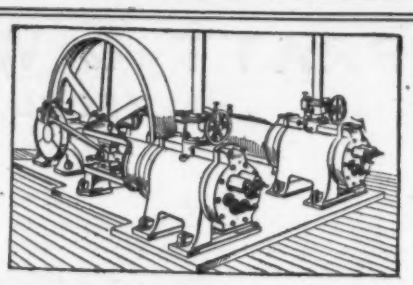

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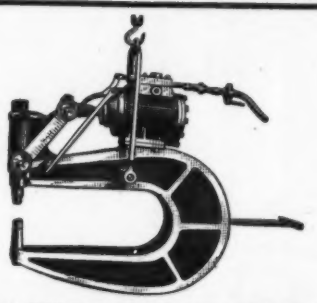

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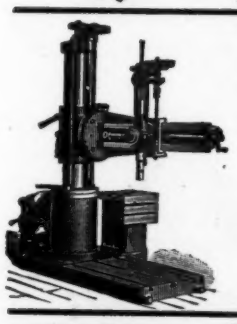

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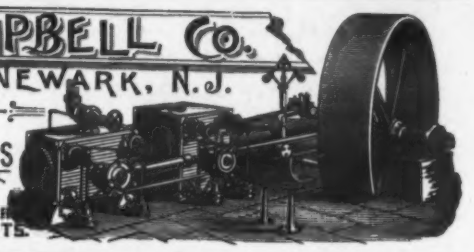

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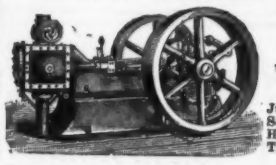

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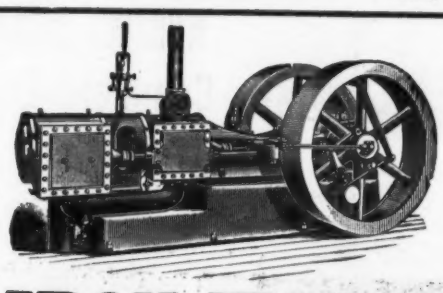

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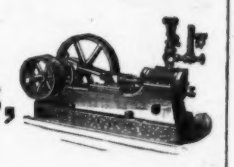

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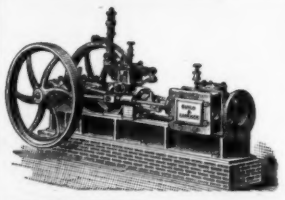

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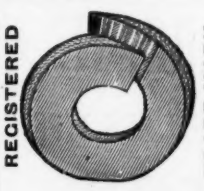

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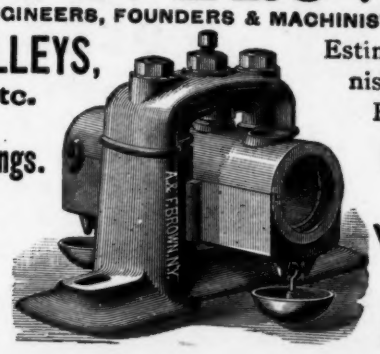

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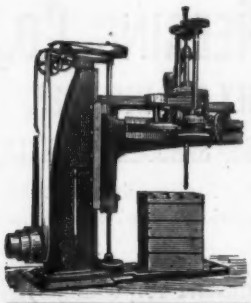

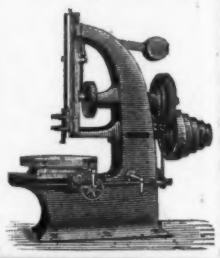

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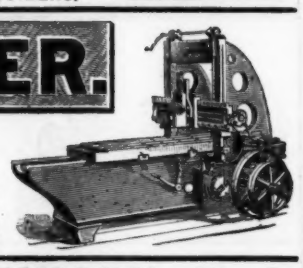

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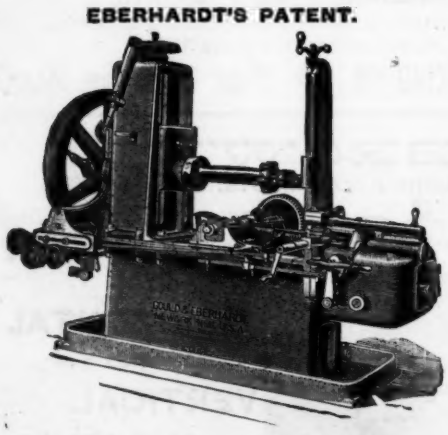

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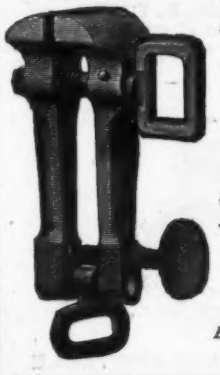

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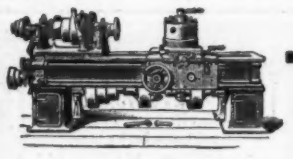

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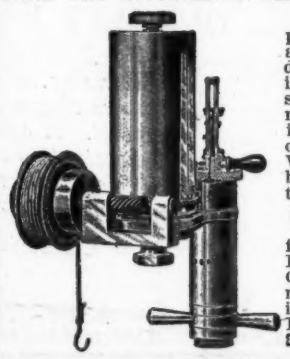

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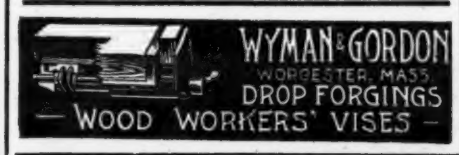

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